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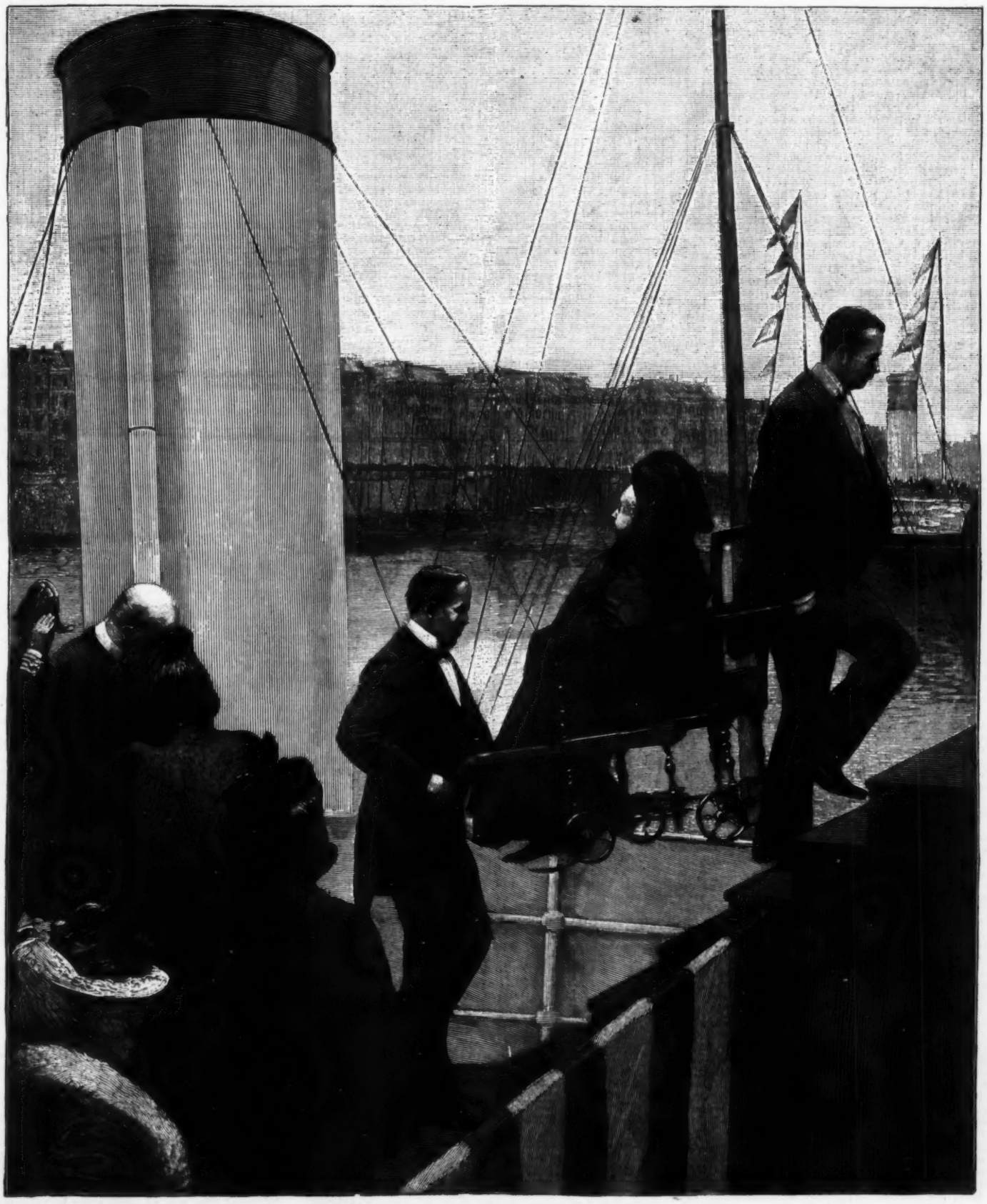

ARRIVAL OF QUEEN VICTORIA AT BOULOGNE.

VISIT OF QUEEN VICTORIA TO FRANCE.

QUEEN VICTORIA, on her way to Nice, disembarked on Saturday, March 11, at the maritime railway station at Boulogne. A crowd of people curious to see England's Queen had gathered on the quay, and after 2 o'clock P. M. all business in the city was suspended.

At 3:30 P. M. the outline of the Chatham Company's steamer "Calais-Dover" emerged from the fog. She had been transformed into a pleasure yacht for this occasion and was escorted by a dozen torpedo boats and the dispatch boat "Irene." If the bridge had not been occupied by Admiral Fullerton, and if the outlookers had not seen moving about on the deck the well known Hindoo servants with which the Queen delights in surrounding herself, he would not have known that one of the great sovereigns of the world was on board the packet-boat. The "Calais-Dover" was not decorated with flags—not even did the Queen's royal flag fly at the masthead.

The band played "God Save the Queen" as the vessel came alongside the quay. At 4 o'clock the Queen stepped down from a specially constructed square pavilion erected on the rear deck, and received the congratulations of the following officials, who had boarded the packet to visit her: Rear-Admiral De Maigret, General Sannerod, M. Alapetite, the Lord Mayor of Pas-de-Calais, Dr. Aigre, Mayor of Boulogne, and many of the principal notables of the city, including the consul and vice-consul of England.

At 4:30 o'clock the Queen passed directly from the steamer to the special car which awaited her. She was placed in a rolling arm-chair and rolled up the gangplank; but, as the tide was low, it was necessary to ascend seven or eight steps in order to reach the top of the quay and board the train. Two strong men-servants picked up the chair, therefore, and carried the Queen up the stairs, after which she was rolled aboard the train over a gayly decorated, temporary bridge. In this manner Her Majesty Victoria made her entrance into France, followed by the Duchess of York, Princess Henry of Battenburg, the Duchess of Schleswig-Holstein, three maids of honor, two gentlemen in waiting, and two Indian princes. The scene lacked pomp, but it must be remembered that England's venerable Queen now no longer wishes to be anything more than the Countess of Balmoral.

The crowd on the quay maintained an attitude of respectful sympathy. It knew that the august sovereign loves France and has no part in the vexatious proceedings of her ministers with regard to our country. At 4:35 P. M. the train started, and its speed, according to the Queen's wish, was not more than thirty-seven miles per hour. At this rate Nice was a day's journey distant, and Her Majesty reached there safely late Sunday afternoon.

We are indebted to L'Illustration for the above description and the engraving.

LEADLESS GLAZES.*

By WILTON P. RIX.

THE use of lead in pottery is most probably coeval with the use of glaze. If the adoption of bitumen and of cerates, to obviate porosity, be considered the first advance, their abandonment in favor of a material requiring ardent heat for its fusion certainly marks the second and the more important change. Though in time the potter discovered the use of alkaline glazes, there is little doubt that lead ore sprinkled on the ware gave the first suggestion and the first desire for the permanence of his wares. Through the ages lead has ever held the foremost place amid all the changes of form and color, material or decoration, facile in its results, brilliant in its effects, yet ever noxious in its influence on human life. Egypt and Assyria have both left examples of supreme ceramic skill, in which the admixture of lead has played a leading part. This shows no mean intelligence in the craftsmen of those days.

There have always been those who in their handicraft are thus intelligent and observant, and, moreover, have nursed the incentive to surpass their fellows. Nor have there been wanting many also who, for the considerations of self, were willing to remain ignorant and unambitious, satisfied merely to follow their fathers' track and justify their path on this account. But new days bring new problems. The potter of the present is faced with fresh difficulties and impelled to new efforts, and not the least of these is the subject which commands our attention this evening. Its solution must finally rest with those men of enterprise among us to whom the mention of a need is but the incentive to attainment.

The importance of the elimination of lead from all glazes needs no demonstration. The attention lately called to its deleterious effects, and the statistics which have been published respecting them, make it necessary for the welfare of the industry that every means should be taken to reduce, if not finally to eradicate, the cause of such serious results.

The total number of persons employed in pottery works throughout the country is over 70,000, of which about 20,000 are under eighteen years of age, about equally divided between both sexes. Two-thirds, however, of the total employed in England and Wales are located in the Staffordshire potteries and engaged in the production of ware in which lead glazes are constantly used.

In a considerable number of potteries lead is absent, and, after deducting the operatives in these, we may fairly conclude that not less than 60,000 persons of both sexes are occupied in works where precautions against lead poisoning become necessary.

It is quite true that a comparatively small proportion of this total are actually exposed to contact with lead; and it is equally true that a very large number of those so exposed work in lead processes for years, and even for life, with complete immunity. Nevertheless, we have to face the fact that to a certain percentage of these, say about 1 in 300, the employment is eventually fatal, while not less than 1 in 8 of the workers so exposed are more or less affected by plumbism.

Such a condition of things, arising as it does entirely from the use of lead glazes, and altogether distinguishable from the loss of life occurring through the deleterious effects of dust and heat, naturally demands the best efforts of the manufacturer to rid his establishment of so insidious an enemy.

The noxious influence of lead upon the human system has been so fully dealt with lately, and the statistics of lead poisoning have been so constantly analyzed and discussed to the disparagement of the pottery manufacturers at large, that it is needless to occupy time in repeating the facts. The disastrous effect of lead in certain cases cannot be too strongly stated. When developed in its most virulent form, lead poisoning is the undoubted precursor of paralysis, blindness, and death.

It is true that the number of cases in which such terrible results ensue form a very small percentage of the whole number of workers tainted with lead; and these again form a still smaller proportion of the total number employed.

The operation of the act of 1895 may be considered to have produced fairly reliable statistics; and though the absence of earlier data makes it impossible to compare the present with former conditions of pottery workers, there are certain facts that deserve notice.

The returns of last year giving the cases of lead poisoning reported in 1896 from the potteries are as follows:

Dippers	78
Ware cleaners, after dippers / Dippers' assistants	78
Glost placers	70
Majolica paintresses	42
Ground layers	48
Printers' transferrers	10
Various	56
Total	382
Out of a working total of, say	45,000

There is reason to believe that the returns for the year just ended will show a marked improvement in some branches, though at present the figures have not been made known.

As might be expected, the dipping, cleaning, and placing of the ware in the ovens contribute most to lead diseases, while the decorating is only responsible for one-third of this number. The increasing use of spraying processes as well as the large proportion of free lead in majolica glazes is no doubt the cause of the heavy percentage of cases in this branch. My own experience, however, leads me to say that this is partly due to want of reasonable precaution on the part of the workers themselves. It is not too much to say that the utmost recklessness often exists among those employed. On the other hand, it is possible to point to instances such as that of the Mersey Lead Works, Warrington, in which the absolute immunity for years from lead poisoning is almost entirely attributed to the loyal co-operation of the workers in observing the regulations.

Statistics also go to prove that the employment of girls in dipping and placing is most undesirable, owing to their greater susceptibility. Of the two, placing is the most dangerous, as the glaze is dry. The peculiar susceptibility of some constitutions is also a well established fact, corroborated by many of the leading employers. Though many have worked a lifetime without contracting any taint, others are found who inevitably become affected in two or three weeks. For this reason, one cannot too strongly approve the adoption of the new regulations which make compulsory the monthly examination of all women and young persons employed in lead processes by the certifying surgeon, who may order suspension from employment of those affected. Such a law is most beneficial, by inducing care on the part of the worker, and promptly eliminating those of susceptible constitutions.

The necessity for such a regulation becomes sufficiently obvious from the chief inspector's last report, in which it is stated, in regard to the effect of lead upon maternity, that out of seventy-seven married women reported as affected by lead, only thirty-six had borne living children, and of these forty per cent. had died in infancy.

Space will not allow notice of the various conditions which tend to induce plumbism. It may be sufficient to point out that they resolve themselves into two main groups:

Want of cleanliness, both of worker and workshop.

Want of ventilation.

Both of these are dealt with under the new regulations, but success can only be secured by the co-operation of the workers, and it is admitted that apathy in this matter is at present the greatest obstacle.

But while the regulation of existing conditions may be important, far greater benefit must obviously accrue from the elimination of lead in pottery operations. In short, it becomes necessary to consider—

1. Whether at present, or by gradual stages, it is possible to exclude the use of lead entirely.

2. If this cannot be done, how far the regulation of its use will mitigate its noxious effects.

3. To what extent the characteristics of wares now manufactured can be modified and public taste so educated and directed that the demands for lead-glazed wares may eventually cease.

These problems are by no means new. In this country, and also on the Continent, for the last half century at least, constant efforts have been made by manufacturers, and also on the part of the respective governments, by means of regulation and research, to mitigate the evils referred to.

So long ago as the year 1794, the Society of Arts offered the premium of a gold medal or £30 "to the person who should discover to the society the cheapest, safest, and most durable composition fit for use for the purpose of glazing the ordinary kinds of earthenware without any preparation of lead, and preferable to any hitherto in use."

This offer was repeated annually for no less than twenty-five years before anyone accepted the challenge, and it was not till 1820 that the smaller or Isis Gold Medal was awarded to Mr. J. Rose, of Coalport, Shropshire, for his improved glaze for porcelain. It will be noticed, however, that this glaze was propounded for porcelain and not for earthenware; and, indeed, it has never proved itself in any way satisfactory for the latter.

It will be interesting to those present to know that by the kind permission of Sir A. Geikie, I am enabled to place before you this evening an early specimen of ware, glazed with this glaze, from the collection in Jermyn Street Museum, which is known to have been produced before 1826. I am also pleased to be able to place in comparison with it specimens of modern manufacture from the same pottery. In connection with these latter examples, the Coalport China Company make the important statement that a leadless glaze has been in constant use up to the present time, and that all services sent out are dipped into it.

As the manufacture of earthenware greatly exceeds that of porcelain and china, the offer of the Society of Arts can hardly be said to have accomplished its purpose. It is true that in view of the fact the original offer was continued in a modified form as "Glazing Common Red Earthenware without Lead," and two years later the gold medal was awarded to Mr. Meigh, of Shelton, for the discovery of such a glaze, but this again could not be made available for general use upon the white earthenware body which forms the staple manufacture.

Notwithstanding the unsuccessful result of these early efforts, manufacturers have not since been indifferent to the matter. During the ensuing thirty years several patents were taken out, and in the year 1865 the subject was brought before the British Association at Birmingham, when Mr. H. Coghill, of Newcastle-under-Lyne, propounded a formula which claimed to have solved the problem of an innocuous glaze. A copy of this recipe is added:

Crystallized boracic acid (84 per cent.)	75	lb.
Crushed soda crystals	75	"
Cornwall stone or feldspar	75	"
Flint, ground, or silex	30	"
Cornwall clay	13	"
Carbonate of lime	50	"

The above to be fritted in a furnace in the usual way.

Take of the above frit	450	lb.
Cornwall stone	150	"
Cornwall clay	50	"
Carbonate of lime	29	"
Flint or silex	20	"

The above ground in water in the usual way, and stained as required.

Though persistent efforts were made to employ this glaze by some makers, they were only partially successful; and though it has been repeatedly tried, it fails to meet the demands of present manufacture. I am informed by Mr. T. Speek Walker that it was in use at Thornaby-on-Tees Pottery for some ten or fifteen years, but after making many efforts to improve it, the attempt was finally abandoned in favor of lead glazing. Uncertainty of result in firing, and consequent heavy loss, as well as the loss of brilliancy in colors, were the chief causes of failure.

At the South Wales Pottery, Llanelly, more than thirty years ago, and for long subsequently, a leadless glaze was used by Mr. Guest, but this also was finally abandoned for similar reasons. Owing to its opalinity, the colors were less bright and the ware lower in quality than when glazed with lead. It has, unfortunately, been impossible to get verified examples of this glaze.

It appears probable that some, at least, of the early wares made at Bow, Chelsea, Nantygarw, Worcester, and Derby were actually produced with lead-free glazes; but there are clear indications that for china these various potteries were unable to avoid the gradual introduction of lead for glazing purposes.

The formula for the Nantygarw china glaze has been stated in a book by Taylor, of Shelton, date 1847, to be as follows:

Lynn sand	8
Chalk	6
Stone	2½
Borax	10
China clay	40
Feldspar	3½
Flint	½
Soda	6
Niter	3

These are fritted together.

Although the quality of the Nantygarw ware was certainly high, attempts to produce the above glaze have not proved successful, nor is it certain that it has ever been in general use.

Of the potteries already mentioned, Derby and Worcester are the only survivals. It may, therefore, be well to note in passing that both at present find it necessary to adopt the use of some proportion of lead in glazing china.

At the Worcester China Works a leadless glaze of fine quality has been used from time to time, and is still adopted both for china and semi-porcelain. By the courtesy of Mr. E. P. Evans I am able to show specimens of these wares. I am told, however, that, though colors stand fairly well under it, the difficulties of working this glaze are considerable, the oven losses being much too heavy.

Attention has already been called to the hard feldspathic glazes for porcelain, such as Chinese, Japanese, and hardware. These have usually required the exclusion of lead, owing to the high temperature at which the glost ware fire takes place.

An altogether different type of leadless glaze is to be found in the soft alkaline glazes of old Persian and Rhodian wares. Neither of these classes of lead-free glazes is of much practical value to the average commercial potter.

Most of the porcelain glazes are too hard for bodies in general use in this country. The alkaline glazes, though fusible enough, limit, by their powerful chemical action, the range of colors available. Besides this, many of them have the serious objection of instability.

In view of the facts, it is not surprising that potters have gradually succumbed before the tempting inducements offered by the use of lead glazes. Indeed, when we realize the exigencies of a market ever demanding finer finish, more perfect texture, greater brilliancy of surface as well as increasing variety of color, and these improvements accompanied withal by a persistent tendency to reduction in price, it is difficult to see what other course was open.

Without the use of lead, none but the most enterprising could be expected to undertake the task of supplying such demands, in face of the difficulties experienced with all other compositions, and it is much to the credit of our leading houses that they have patient-

* Paper read before the Society of Arts, March 1, 1899, and published in the Journal of the Society.

ly and unremittingly set themselves to solve the problem. With what success, so far, it will be one of the objects of the present paper to demonstrate, and also to show the chief obstacles surrounding it. Before doing so, it is necessary to glance at the commercial considerations which have hitherto made the use of lead almost indispensable to the manufacture as now carried on.

Foremost among these is that of economy.

It is necessary that the firing temperature should be kept as low as possible to save fuel. Losses must be reduced by extending the margin of risk in every stage that will allow of it. Many bodies and glazes, admirable in all other respects, have now to be abandoned solely on this account. Unfortunately, in both these directions leadless glazes stand at a disadvantage in comparison with those now used.

There are also many other points of equal importance to be demonstrated before so important a change can be universally brought about.

The potter's art is essentially complex. Each process, though simple in itself, is one of many, all affecting the final result, and the possible combinations of which are infinite. Even when a successful result is obtained it must be proved capable of withstanding the great diversity of treatment before it can be put on the market.

The potter is compelled to move with caution when leaving the beaten track, otherwise he would soon be lost in a confusion of results, the causes of which he would be unable to trace.

Any changes made call for exhaustive tests as to loss in production, or failure in actual use, and these experiments may often occupy months and even years.

The manufacturer builds up the reputation of his product by a process of selection, based on the survival of the fittest methods, patiently noting those best adapted to his object. He is essentially and rightly conservative, being well aware that all the various details of each stage are so interrelated and interdependent that a readjustment of one may destroy the balance of the whole.

Evolution, and not revolution, is the watchword of a potter, and economy dictates that among the many combinations he should limit his selection to some definite treatment.

Given a certain material, the heat at which this can safely be biscuited is limited by its composition. This, again, must define the range of possible glazes. These in their turn govern the character of color available, as well as the method of production and decoration. Such radical departures from well known lines as are involved in the abandonment of lead can, therefore, only be arrived at through lapse of time. Meanwhile it is possible that the more complete introduction of properly fritted lead may prove a means of mitigating the evils in question, while experience is being gained for the final change.

Leadless glazes inevitably affect colors used at present in a different manner, so that the elimination of lead would probably involve a readjustment of the underglaze color compositions, and the disappearance of some tints from the potter's palette, and this in itself is a serious consideration.

In short, potting with leadless glazes, if applied to earthenware—by far the largest section of the trade—becomes practically a new manufacture. And it is doubtful whether the attempt to suit present bodies and match present colors is in all instances likely to succeed. It is true that there are times when it is the best interest of a manufacturer to readjust his methods to new conditions. Such radical changes, however, always involve large sacrifice of plant and serious outlay. But the small potter with limited capital has no margin for such sacrifice. To him such a change, if compulsory, would mean ruin.

Notwithstanding these obstacles it is clearly the duty of every manufacturer to do all that is possible, having due regard to commercial success, toward erasing lead from the potter's list of materials, and the present is an attempt to show what advance has already been made in this direction.

Even under the most favorable conditions the change to lead-free wares is likely to lead to increased cost of production, and unless it can be shown that foreign manufacturers are placed under similar conditions any attempt at the compulsory exclusion of lead could only drive the trade away from the country. In other words, nothing short of international legislation is likely to bring about the entire abandonment of lead in favor of other materials.

Experiments have doubtless been made ad infinitum, but from the experimental to commercial stage is a long step. A glaze must prove itself worthy over a large series of ovens, in average state of repair, and also be proved capable of standing equally in all parts of the oven. It must give sound texture on all kinds of ware. Very few leadless glazes have survived the preliminary ordeal, while still fewer have yet entered the commercial stage. Examples of all these have been obtained as far as possible, and by the courtesy of the various makers are shown here this evening. In addition to these, a number of specimens of glazes which are promising, but not yet fully proved, are placed for comparison. I have further thought it well to illustrate the chief defects of such glazes by a few typical failures.

I may perhaps be allowed to add one or two notes, giving the salient characteristics of the most important of these examples.

Next to those of Coalport, the works from the factory of Messrs. Thomsberger and Hermann, of Colditz, command notice. This firm has persistently given its special attention to leadless wares, wisely accepting, however, the limitations of material. The specimens show that good effects can be obtained with underglaze color even in those delicate tones usually liable to be destroyed by such glazes.

In this country, the revival of attempts to abandon lead has been carried on with great energy at Minton's works, where Mr. George Leason has been successful in making a glaze suitable for earthenware. This has now passed beyond the experimental stage, and is being used on ware over all colors under ordinary conditions. It is fired without special treatment at the same temperature as lead glaze, and in all parts of the same ovens. This ware has for the last six months been thoroughly tested, both on land and sea, with very good results. It must, however, need the lapse of a somewhat longer time to make it possible to give a final verdict as to the soundness under all circumstances. Examples of this ware are on the table, from which it will be seen that the glaze is equally successful on china and earthenware. The workpeople using it, however, state that the difficulties of manipulation are greater, and in dipping especially much care is necessary.

Messrs. Doulton, with their usual enterprise, have faced the problem of non-poisonous glazes and made an exhaustive series of experiments. The examples shown prove the glaze, when carefully fired, to be of good texture, free from injury to most colors, and equal to the requirements of the market.

Among the remaining pieces, those emanating from Messrs. Copeland's, of Stoke-on-Trent, appear to have many good qualities, and hold their own, in comparison with lead glazes, on the score of texture, freedom from injury of colors, and opalinity when very thinly dipped. As, however, the quantity of ware hitherto produced is limited, it is not yet possible to speak definitely on its merits.

The examples of ware produced by Mr. Reeves, of Fenton, are interesting, as showing the behavior of leadless glazes upon coarser earthenwares when fired at a lower biscuit heat. The chief difficulty of working such glazes lies undoubtedly in the comparatively low temperature of the biscuit fire at present adopted.

It appears certain that more satisfactory results could be obtained if bodies were so composed that biscuit could be fired some 100° C. (say to cone 6 or 7) than at present, thus enabling the heat of the glost fires to be increased in the same ratio. By this means a higher percentage of alumina could be introduced into the glaze, and compounds of the feldspar lime type would become available. But the heavier cost of fuel would often preclude the use of harder biscuit. It is therefore satisfactory to find that this is not absolutely necessary to success.

Of the remaining examples which are without color, those of the well-known factory of Villeroy and Boch, of Mettlach, claim attention. Regarding these, the makers state that, provided due care is used, they do not experience greater loss with leadless glazes, and that the treatment in firing is the same as for lead glazes. The results obtained with underglaze colors depend upon the adjustment of these as well as on the firing.

Among those producing for the general market, Messrs. Harrison and Son, of Hanley, have already shown themselves successful in furnishing leadless glazes of high quality, capable of use without injury to colors. The examples include printed and handpainted decoration underglaze, besides others demonstrating the suitability of the glaze for use with lithographic overglaze transfer. These last show the effect of second fire on the glaze, also that the texture is sufficiently smooth to receive the transfer without loss of detail.

Among those who have devoted attention to the matter, Mr. Furnival, of Stone, has experimented with some success, and examples of his most promising glazes are here shown. They have been tested with approval by some manufacturers, and they appear to have the merit of working well with most underglaze colors.

Notwithstanding the apparent success of the elimination of lead in the foregoing specimens, it must by no means be assumed that they afford decisive proof that the general adoption of lead-free glazes is yet possible. A very large range of body mixtures fired at various biscuit heats are now in use, and for many of these glazes without lead may prove unsuitable. It is necessary to prove whether greater expenditure in fuel is needed, and also how far the most accurate control of the glaze-dipping and firing can be met. Such a change cannot be made till the new product is shown to be free from greater expense in manufacture.

It is, therefore, still necessary as a precaution, while further experience is being gained, to find the best means of reducing the necessary lead in the present glazes, and to secure the permanent fritting of the whole.

It has long been known that the combination of the various elements in question takes place in the ratio of their equivalent weights, and unless the frit mixtures are adjusted with due regard to the combining weight, the excess of base or acid must remain in a free state.

Hence the fritting of lead with silica, or borax or stone, can only produce innocuous results when the proportions of each are such that the whole is chemically combined in a stable form. Some indications of the effects of incorrect proportions are given in the tables appended:

Analyses, showing amount of free lead in various frits, dissolved from 1 part by 50 parts of a solution containing 0·33 per cent. hydrochloric acid, and at a temperature of 100° Fah.

I.

White lead	80	66	60	50
Flint.....	20	34	40	46
Percentage of free lead..	24·01	19·47	12·95	14·34

II.

White lead...	80	66	60
Stone.....	20	34	40
Percentage of free lead.....	23·55	15·02	12·10

This problem of proportion would appear simple enough were it not that some of these more complex mixtures produce frits which are either soluble or are liable to disintegrate on exposure.

The addition of borax in any large proportion is especially to be avoided when fritting lead; and it is definitely ascertained that if the percentage of boracic acid and lead oxide amounts to 40 per cent., the frit is noxious.

The combination of such frits can be better controlled by the preparation of alkaline and lead frits separately, thus checking the tendency to form unstable compounds. The addition of alumina also assists in obviating these difficulties, though it increases the difficulty of fusion. It is, however, clear from what has been stated that, unless combined in definite proportions, the fritting of lead is no safeguard. Experience has already shown that many lead frits are noxious. Prof. Laurie has shown, as a result of his investigation, that silicate of lead was soluble under the usual test to the extent of 12 per cent.; and the inquiry recently completed by Prof. Thorpe, when issued, will no doubt afford the potter full information on this important point.

Another important point to be decided is the minimum of lead possible to retain with success. In this connection I am pleased to be able to produce specimens of Messrs. Copeland's china, the glaze for which contains only 9 per cent. of lead, the quality of the ware being entirely satisfactory.

It is well to note that, in comparison with any other material, equal increments of heat have far greater effect on lead as regards fluidity, and this property insures that smoothness of texture and extreme brilliancy of glaze which is, so far, conspicuously absent in most leadless glazes.

Knapp has shown that those glazes which possess the highest degree of luster and greatest power of refraction are those which exhibit the highest specific gravity. But it is an important point that the exclusion of lead from glazes removes from the list the only material capable of imparting the needful density. We can, therefore, hardly expect to secure equal brilliance in glazes so essentially lower in refractive power.

Undoubtedly, we possess in baryta one notable exception, and in glass making fairly good success is attained with it, as will be seen by the example here shown. It is, however, a question whether this material is sufficiently innocuous to be admitted as an available substitute.

Lead has also the important quality of arresting devitrifaction, thus insuring stable glazes. The tendency of many alkaline glazes to become reconstituted on exposure to damp air is well known, and the elimination of lead removes one of the most efficient antidotes.

We have in most leadless glazes three objectionable properties, viz., opalinity, sluggish fusibility, and inequality of texture.

The defects of opacity and opalinity cause the rejection of many otherwise suitable formulæ. Such examples of leadless frits are shown here, as well as a comparison of lead and leadless glaze on red body fired together. I have endeavored to deduce from the structure of some of these the actual causes of their opalinity. From examination under the microscope by polarized light this defect seems in no way due to semiopacity, or suspension of opaque particles in a transparent matrix. It is apparently caused rather by a want of complete uniformity in the construction of the mass, which is in reality made up of two or more separate elements of differing refractive powers, distinctly noncrystalline and in no sense opaque. On the other hand, the opaque, leadless frit here shown exhibits altogether different construction, being merely translucent and not of uniform texture.

The fault of sluggish fusibility is also a serious objection. It leaves the slightest inequality of thickness still apparent after firing. Any small scratch on the unfired piece also remaining unchanged—instead of "healing" in the oven, as with lead glaze. The mending of such fault on the raw glaze by penciling is impossible, for the same reason.

The production of combination least liable to this defect is one of the most important problems connected with it. The absence of lead appears to have two effects. It causes the glaze to be more viscid, but it also makes it slower in its response to the fusing temperature, as well as to the accession of heat.

To demonstrate this, I have had prepared by the very kind assistance of Mr. William Burton a series of examples showing the behavior of both types of glaze under precisely the same conditions. A comparison is given of the effect of firing rapidly up to Cone 01·1 (i. e., hard glost heat) in six hours, demonstrating very clearly the greater tractability of lead glaze under quick firing.

For this reason, as well as many others, glazes without lead must be dipped as thinly as possible, besides being used at a lower "slop" weight than lead, and much more uniformity of dipping is necessary.

The defect of surface inequality gives rise in some glazes to an egg shell or pitted texture, which deprives the ware of the smoothness so essential to cleanliness, at the same time causing it to lack that brilliance now demanded by the public. It is of course too early to say that these difficulties cannot be overcome, but much attention and experience are still needed to accomplish this.

We have next to consider the possible substitutes for lead, and in doing so we are compelled to exclude those which are too expensive or scarce, those which are too low in color, and, lastly, those which are noxious.

Of the rest, the list at present is limited to the alkalies and borax, the alkaline earths, and boracic acid. Taking these in order, we find in soda and potash danger of disintegration, destructive influence on colors, and tendency to crazing, to be the chief defects which limit their use in any large proportion.

Of the alkaline earths we have lime, magnesia, and baryta. The former can only be used in small proportions. If the maximum exceeds one-eighth, opalinity ensues.

Magnesia is insufficiently fusible, and hitherto no very satisfactory glazes have been produced with it.

Barytes has received the careful attention of that able chemist Dr. H. Seger, who has undoubtedly produced many successful glazes from it. They are, however, subject to the same drawbacks as to texture and do not yield a sufficiently glossy surface.

Boracic acid, though imparting hardness and brilliancy to glaze, has injurious influence on some colors. Its use is therefore limited; but, in conjunction with silica, in carefully adjusted proportions, it has produced some of the best glazes at present discovered.

In considering the possible treatments in composition it is necessary to decide the glost temperature. Naturally the practical potter prefers to keep this as before. But the want of fluidity already noticed suggests an increase of heat in the glost oven as desirable. Dr. Seger pointed out that for lead-free glazes heat should exceed 1,050° C. But, as a rule, the earthenware biscuit is only slightly above this, and serious loss would result unless the body were changed.

Another expedient for assisting fluidity is the increase of the number of basic oxides, and this is certainly practicable. That it is, however, not absolutely necessary, is shown by the formula of a successful

glaze, in which it will be noted that there are only two bases:

$$\left.\begin{matrix}0{\cdot}325\ K_2O\\ 75\ Na_2O\end{matrix}\right\}\ Al_2O_3\ 1{\cdot}284\ \left\{\begin{matrix}SiO_2\ 9{\cdot}200\\ B_2O_3\ 1{\cdot}262\end{matrix}\right.$$

The examples shown are certainly good.

The appropriateness of including baryta as a substitute for lead is rather doubtful. It is difficult to trace any directly harmful effects to its use, and it has been distinctly stated by those constantly working with baryta that no evil result has ensued. Such glazes have been largely used, to my personal knowledge, for many years without the slightest ill effect on the workers. On the other hand, the distinct opinion is expressed by medical experts that it has several of the properties of lead, and being a poisonous metal, it cannot be considered very safe. Notwithstanding this, Dr. Seger has proposed the substitution of barium glazes containing boracic acid for those of lead, of which the following are examples:

NO. I.

Frit.		Mill.	
Heavy spar ..	125·3	Frit....	292·5
Calcined soda..	13.25	Zettlitz clay	25·9
Crystal borax..	143·2	Sand.....	18·0
Sand.....	126 0		
Charcoal	15·0		

$BaO, NaO\ 4{\cdot}5SiO_2.1{\cdot}5BO_3$ (3:1)

This fuses about midway between silver and gold heat.

NO. II.

Frit.		Mill.	
Heavy spar....	125·3	Frit ...	297·5
Crystal borax..	191·1	Zettlitz clay	25·9
Sand....	111·2	Sand... ...	3·0
Charcoal.....	15·0		

$BaO, NaO, 4SO_2.2BO_3$ (2:1)

This type of glaze is said to have been successfully worked in some German potteries, though there is no instance of its adoption in this country.

In America, Mr. Karl Langenbeck, of Zanesville, O., who has given some attention to the matter, states that he has made glazes from Dr. Seger's formulæ, and practically applied them with complete success on a manufacturing scale, comparing favorably with lead glaze in regard to cost. Owing, however, to their eggshell texture and the absence of the brilliant glaze required on tiles, their introduction did not satisfy public taste. As regards their effect upon colors, the barium glazes suitable for earthenware showed to disadvantage. But in the case of soft glazes for quick muffle firing of the type of the second formula here quoted, the brilliancy of colors was even greater than those made with lead.

As an additional example of these glazes I quote the following which has been proved by Mr. Charles Binns, of Trenton:

$$\left.\begin{matrix}CaO\ 0{\cdot}35\\ K_2O\ 0{\cdot}20\\ Na_2O\ 0{\cdot}25\end{matrix}\right\}\ Al_2O_3\ 0{\cdot}2\ \left\{\begin{matrix}SiO_2\ 3{\cdot}0\\ B_2O_3\ 0{\cdot}5\end{matrix}\right.$$

Besides the barium glazes above named, it is also possible to produce leadless glazes having lime and alkalies for the bases, and in this direction also Dr. Seger made considerable research.

His experiments go to prove that the formula

$$\left.\begin{matrix}K_2O\ 0{\cdot}6\\ CaO\ 0{\cdot}4\end{matrix}\right\}\ \left\{\begin{matrix}SiO_2\ 2{\cdot}5\\ B_2O_3\ 0{\cdot}5\end{matrix}\right.$$

gives a glaze fusing at silver heat, and clear slightly above gold heat. Also that the following formed a glaze of general utility:

$$\left.\begin{matrix}K_2O\ 0{\cdot}6\\ CaO\ 0{\cdot}4\end{matrix}\right\}\ Al_2O_3\ 0{\cdot}8\ \left\{\begin{matrix}SiO_2\ 5{\cdot}0\\ B_2O_3\ 1{\cdot}0\end{matrix}\right.$$

the possible limits being

$$\left.\begin{matrix}K_2O\ 0{\cdot}2\\ CaO\ 0{\cdot}8\end{matrix}\right\}\ Al_2O_3\ 0{\cdot}6\ \left\{\begin{matrix}SiO_2\ 5{\cdot}0\\ B_2O_3\ 1{\cdot}0\end{matrix}\right.$$

$$\left.\begin{matrix}K_2O\ 0{\cdot}3\\ CaO\ 0{\cdot}7\end{matrix}\right\}\ Al_2O_3\ 0{\cdot}5\ \left\{\begin{matrix}SiO_2\ 4{\cdot}0\\ B_2O_3\ 0{\cdot}5\end{matrix}\right.$$

gives a clear glaze, but the boracic acid, when doubled, causes opalinity, and this quantity on being again doubled, produces a milk white glass.

With regard to the proportion of bases, the limit is:

$$\left.\begin{matrix}K_2O\ 0{\cdot}2\\ CaO\ 0{\cdot}8\end{matrix}\right\}$$ as more lime causes opalescence in all cases.

The question of permanence and stability of all glazes without lead is one of no small importance. Owing to the large place occupied by the alkalies as fusible basic substitutes for lead, it is easily possible to obtain combinations which would prove disastrous in this respect, for whereas lead has proved a reliable support to stability, the alkalies are notoriously treacherous. I am able, however, to show you a tile which has been exposed for nearly twelve months which shows no change. I understand that Messrs. Mintons also have, for considerable time, tested their new ware under trying changes of temperature and climate, so far with complete success.

Doubtless little opportunity has occurred to thoroughly prove the latest mixtures. All that can be said is that they have at present stood the most severe exposure and the roughest usage without injury. It may, however, be safely stated that with the exercise of due intelligence in compounding a formula, no serious risk need be incurred. The scientific data available are amply sufficient to protect the potter if he will. But if he still persist in mingling ingredients in haphazard proportion without regard to the unalterable laws of chemical combination, he can only expect haphazard results.

In face of the important problems at issue, we need to recognize that pottery manufacture is a science as well as an art, and that it is subject to laws as definite as those which govern the use of electricity, light, or heat.

More than a century has elapsed since the first attempt was seriously made to eliminate lead from pottery. The use of leadless glazes has been fitful and exceptional. Up to the present it cannot be said that for the bulk of the trade they have proved practicable. Within the last five years every Staffordshire potter pronounced their adoption impossible. Since that time such advance has been made that some, at least, of the most strenuous opponents have confessed that their views are modified, and that for many classes of ware lead is no longer a necessity. Some go so far as to think that, with increased experience, leadless glazes may become available for nearly all kinds of goods.

I am inclined to believe that such a result is only a matter of time. Having become fully cognizant of the limitations and difficulties attending their use, the potter will, no doubt, bestow renewed energy upon the task of bringing their treatment under his complete control.

Herein, most emphatically, lies the opportunity for the craftsman of the future. Conquest of the technique, rather than the initiation of new processes, must occupy his skill. Scientific economies rather than empirical discoveries will, undoubtedly, mark the progress of the coming century; and that progress must be along the line of a more accurate knowledge of the operations of great principles already laid down, rather than in the search after new ones.

THE SARCOPHAGUS OF PRINCE BISMARCK.

WHERE Otto of Bavaria marched through the mountain pass of Tyrol on his way to Greece, where once Ludwig the Bavarian besieged the fortress of Kufstein and endeavored to extend the boundaries of Germany to the garden-like Unter Inn Thal, there now stands in a village hard by the present border line between Tyrol and Bavaria a sarcophagus which has attracted the attention of crowds of Tyrolean and Bavarian miners; for at the foot of the pale red stone-coffin there may be read in letters of gold: "Fürst von Bismarck, ein treuer deutscher Diener Kaiser Wilhelm's I." (Prince von Bismarck, a faithful German servant of Emperor William I.)

How did this splendid piece of stonework find its way to this quiet village, the last of its kind in the southern part of the mighty German empire of old? The little village of Kiefersfelden, surrounded by marvelous Bavarian mountains, is the center of an extensive marble-industry which gives employment to a large number of men, and which supplies the marble for most of the public buildings in Germany.

SARCOPHAGUS FOR THE BISMARCK MAUSOLEUM AT FRIEDRICHSRUH.

No fewer than twenty-three quarry-owners vied with one another to secure the contract for making Bismarck's sarcophagus. But the family of Germany's great chancellor finally decided that the Kiefer works should make the marble coffin, a decision which might possibly have been influenced by the words which the owners of the Kiefer quarries added to their application: "Unser Bismarck, des deutschen Reiches ester Kanzler soll in untersberger Marmor liegen." (Our Bismarck, the first chancellor of the German empire, shall lie in the marble of Untersberg.) And accordingly the stone which was to inclose the ashes of Bismarck has been cut from the quarries of this storied Bavarian region, from the very throne-hall of Kaiser Karl the Great, in Untersberg.

The marble-quarries of Untersberg are two and one-half miles in length. They have been owned by the Kiefers ever since they ceased to be the property of the crown. The finest marble ever quarried in Untersberg has been used by Ludwig I. in his classic Munich structures, and by Ludwig II. in his fairy castles. Many monuments, churches, and private dwellings are ornamented with marble from Untersberg.

A piece of marble faintly tinged with red was selected for the sarcophagus, and cut according to the plans of the Hanover architect Schorbach, the builder of the Bismarck mausoleum. The sarcophagus rests upon a sienite socle and is flanked by little columns with beautifully carved bases and capitals. The mouldings, the two gables, as well as the roof-like cover, are also richly ornamented. At the foot of the sarcophagus there is written in golden letters that legend which has become famous, and which informs the reader that the "faithful German servant" is sleeping within those marble walls.

The impression made upon the observer is lasting; for the marble coffin is stately, simple, and imposing in appearance. The selection of pale red marble was particularly happy, as it possesses nothing of that coldness and stiffness characteristic of Carrara marble.—Illustrirte Zeitung.

COAL FOR A BIG HOTEL—HOW IT IS HANDLED.

THERE are many things about the management of a large hotel, says The New York Tribune, which the patron takes for granted without inquiry or investigation. He can form no idea of the methods employed from what he sees in the office, the corridors, the dining-rooms and the other parts of the building to which he has access, and there are not many guests who wish to pry into the secrets.

For those who take an interest in such matters the arrangements for receiving and disposing the coal are not the least interesting. The Waldorf-Astoria uses one hundred and forty tons of coal every twenty-four hours during the winter months. This coal is all delivered on the Thirty-fourth Street side of the building, but one rarely sees a coal cart in front of the hotel. It is all of the pea and buckwheat sizes, and is dumped from the carts into an opening in the ground in the middle of the Astor Court roadway. It falls into a hopper which holds about ten thousand pounds, and from there it is carried on an endless chain provided with buckets to a vast coalbin which has a capacity of seven hundred tons. Daylight never reaches this bin, which, with its few blinking lights and great piles of coal reaching nearly to the vaulted roof, looks like a corner in a coal mine and little like an annex to a palatial hotel. By an arrangement of levers the coal may be dumped from the buckets at various points, so that with the aid of a shoveler it may be evenly distributed in the bin.

The boiler-room is situated lower down in the ground, and the coal reaches the fireboxes without being handled. When the boiler attendant needs coal for his fire, he pulls a lever which opens a trap, and through this half a ton of coal falls into a feeder which looks like a monster funnel. When the feeder has been filled, it is pushed forward on an overhead track, and when it has reached the proper point, a trap in the narrow end of the funnel is drawn aside and the coal drops into a trough in front of the firebox, whence it goes into the fire.

From the time it leaves the coal wagon until it enters the fire the coal takes care of itself, and with the exception of the straightening out in the bin, which is done by one man during the day and one man at night, and the distribution over the fire surface by the boiler attendant, the one hundred and forty tons of coal which are used every day are handled by machinery.

HOW TO REMAIN YOUNG.

To drink the waters of the fountain of youth is still, in the opinion of some, within the range of possibility. A recent writer observes that a man begins in a gelatinous condition and ends in an osseous or bony one. He is soft in infancy; he is hard in old age. Aging is a process of ossification. After middle life has passed a more marked development of the ossific character takes place. The arteries become thickened with calcareous matter, and there is interference with circulation, upon which nutrition depends. The whole change from youth to old age is one of steady accumulation of calcareous deposits in the system. Entire blockade of the functions of the body is a mere matter of time, and the refuse matter deposited by the blood through the system stops the delicate machinery we call life. The blood contains compounds of lime, magnesia, and iron. In the blood itself are these earthy salts. In early life they are thrown off; in age they are not. Almost everything we eat contains these elements for destroying life. Earthy salts abound in the cereals, and bread itself, mistakenly called "the staff of life," is one of the most calcareous of edibles. Nitrogenous food also contains these elements; hence a diet made up of fruit is best for people advanced in years. The daily use of distilled water is, after middle life, one of the most important means of preventing secretions and derangements of health. Diluted phosphoric acid is one of the most powerful influences known to science for shielding the human system from the inconvenience of old age. Use it daily with distilled

water, and so retard the approach of senility. To retain perpetual youth avoid all foods rich in the earth's salts, use much fruit, especially juicy, uncooked apples, and take daily two or three tumblerfuls of distilled water with about fifteen drops of diluted phosphoric acid in each glassful. Thus will your days be longer in the land.—Medical Age.

WOEHNELT'S ELECTROLYTIC CIRCUIT BREAKER.

DAVY, Planté, and particularly M. Violle, professor of chemistry in the School of Arts and Trades, have studied carefully the electrolysis of acidulated water by currents of high tension. The last named physicist, who is moreover a member of the Academy of Sciences, read to his confreres, in 1892, a paper on a singular

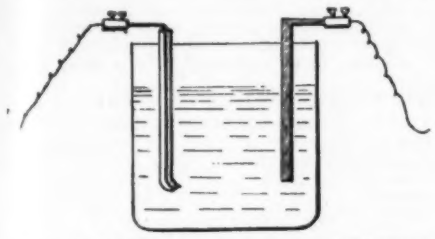

FIG. 1.—DIAGRAM OF THE WOEHNELT ELECTROLYTIC INTERRUPTER.

phenomenon which he had observed in 1889 while working with his collaborator M. Chassaguy.

If with a current of from 40 to 110 volts he used a lead jar as a receptacle for the electrolyte and attached the negative wire to it, a luminous envelope was seen to surround a platinum wire set into the liquid and acting as the positive electrode. A strident noise was also heard, which was altogether characteristic.

From its origin, he explained this strange noise as coming from the interruption of the current of the battery, and this theory was established as correct in 1892 by means of experiments made with a telephone by MM. Kosh and Wüllner; but no one dreamed of making any use of it.

M. Woehnelt, professor at the Technical High School, Charlottenburg, Germany, who has already become celebrated from his experiments with Branly telegraphy, had the idea of making use of this remarkable property for doing away with the mechanical circuit breaker of the Ruhmkorff coil, and he succeeded in a quite remarkable manner. He devised a simple and ingenious method which should serve to place his name beside those of Hertz and Roentgen.

Deprived of its complicated circuit breaker, which does away with its effect to a great extent, the Ruhmkorff coil becomes an instrument of the first order, of almost unlimited use in some directions. It is, therefore, important to recall that this instrument was not invented by Ruhmkorff, whose name it bears, and who only perfected it, but by Masson, professor of physics in the College of Louis the Great, Paris. I was a student in the college in 1846, and saw myself his spark coil in operation. It is great injustice that the name of the assistant whom he employed was given to the instrument. Masson's writings on this branch of electricity would fill a volume easily. They have been published for the most part in "The Annals of Chemistry and Physics."

The first French scientist to learn of the invention of Dr. Woehnelt was M. Hospitalier, formerly editor of L'Electricien and correspondent of La Nature and now a professor in the School of Physics and Chemistry, Paris. He immediately repeated the experiments and showed them to M. D'Arsonval and M. Radiguet, the well-known electrician of the Boulevard des Filles-du-Calvaire.

M. D'Arsonval read a very interesting communication at the meeting of the Academy on February 27, 1899, while Radiguet placed an apparatus in his laboratory in order to study it. With the help of his assistant, M. Massiot, he made some experiments, using the current at 110 volts.

Fig. 1 shows the electrolytic circuit breaker in its primitive form, which M. Radiguet has greatly improved upon. The right or negative pole is a wire or

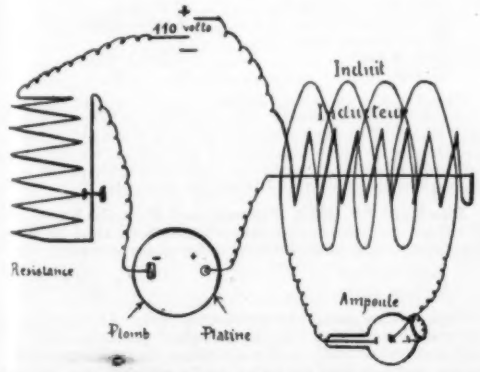

FIG. 2.—LABORATORY APPARATUS FOR THE PRODUCTION OF ROENTGEN RAYS AS MODIFIED BY M. RADIGUET.

plate of lead. The left (positive) pole consists essentially of a platinum wire sealed in a glass tube with the end projecting. Fig. 2 represents a complete installation for the production of Roentgen rays. The current passes through a variable resistance to the negative pole or lead plate of the interrupter, and from the positive pole or platinum wire of the interrupter it passes through the primary wire of the induction coil, thence back to the source of the current. The X ray tube is placed in the secondary circuit as usual. With a current of 3 amperes, he succeeded in filling a tube 18 cm. in diameter with a steady, brilliant, and uniform light. The rays emitted from such a source of light can be used to illumine the thorax and show the least peculiarity of its organs. We have seen a man inspect the heart beats of his wife in this manner.

The phenomena are the same with the alternating current, because it appears, in this case, the circuit breaker allows the current to pass only in one direction. M. D'Arsonval showed this to be so by passing the secondary current through a Crookes tube, which was illumined in the same way as when a continuous current is used.

A coil used by M. D'Arsonval for his high frequency medical apparatus gives, according to his statement, a much greater effect with the electrolytic circuit

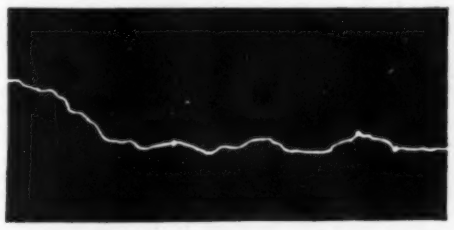

FIG. 3.—SPARK WITH ORDINARY INTERRUPTER.

breaker than with the mechanical interrupter of Foucault.

Fig. 3 is a photograph of a spark obtained by M. Radiguet with a coil 13¾ inches in diameter and a Foucault circuit breaker. Fig. 4 shows a spark obtained with the electrolytic circuit breaker through half the space. Fig. 5 is a spark produced the same way in one-quarter the space. The spark is then so large that it produces a continuous flame, or rather a sort of incandescent streak of light. When the pitch of the sound produced is calculated, it is found to correspond to 1,500 vibrations per second, while with the mechanical circuit breaker more than 100 vibrations per second are never obtained.

With a coil giving a 1½-inch spark M. D'Arsonval says he has obtained as many as 3,000 vibrations per second. If a key is placed in circuit with the primary coil, an excellent apparatus is obtained for projecting Hertzian waves for some distance, and, in this manner, telegraphing without wires. M. Branly conducted some experiments at the Catholic Institute, by which he demonstrated that with a sending station equipped with instruments of rudimentary simplicity, the same

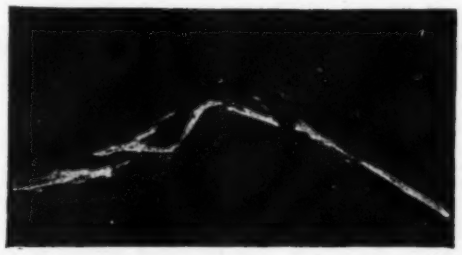

FIG. 4.—SPARK FROM SAME COIL WITH THE WOEHNELT INTERRUPTER AS MODIFIED BY RADIGUET.

results can be obtained as with the most complicated resonators. Of course, there is scarcely any modification to be made at the receiving station.

In his communication of February 27 M. D'Arsonval only described the voltmeter used by Violle and Chassaguy in their early experiments. M. Branly modified the form in his experiments and placed his positive platinum wire inside a coiled sheet of metal.

A very active spark is obtained, even with a small coil 4 inches in diameter, which, although it does not give a very long spark, makes a lively flame between the spherical terminals. With 3 amperes and 20 volts a very interesting experiment can be conducted, while with a greater quantity of electricity and a larger coil the vibrations of the spark might cause an accident and damage the coil.

M. Radiguet has succeeded in obtaining quiet and uniform sparks with 3 amperes and 110 volts, and the photographs which we reproduce are made from sparks obtained in his apparatus. He lays the negative sheet

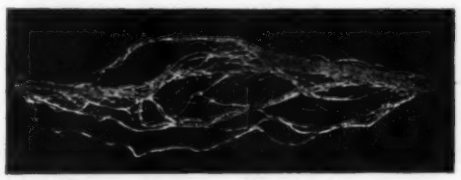

FIG. 5.—SAME COIL AND CURRENT.
Explosive distance, 6 inches.

of lead flat upon the bottom of a large cylindrical vessel about a foot in depth, which contains from three-quarters to one gallon of acidulated water. The positive pole is a platinum wire placed inside a glass tube suspended in the water a short distance above the lead sheet. An envelope of flame surrounds the wire, and the before mentioned strident noise which seems to accompany the spark is heard.

As a general thing, whatever may be the arrangement of the apparatus, it is necessary to govern the temperature of the electrolyte, for, if it rise too high, the circuit breaking effect ceases. A simple way of keeping the temperature from rising too much is to use a larger vessel.

In a letter on page 439 of Nature (the English paper) for March 9, Mr. John McIntyre made some very interesting practical remarks, for he conducted his experiments with a large coil giving sparks over 26 inches in length—twice as long as those M. Radiguet produced. After having eulogized this new circuit breaker, this able electrician remarks that it is adaptable for use in several directions, as follows:

1. As with the Foucault circuit breaker, the voltage of the primary current may be varied by means of it. With 40 volts, a large coil may be burned out.

2. Both the shape and the arrangement of the electrodes may be varied, as was done by M. Radiguet in constructing his simple form of apparatus.

3. The proportion can also be varied, but it must be borne in mind that by increasing this, the conductivity of the liquid increases and there is danger of melting the platinum wire of the positive pole and destroying the glass tube which incloses it.

4. The distance between the electrodes may be varied in like manner.

5. The number of electrodes may be increased. We understand that Mr. McIntyre is experimenting in this direction, but his results are not yet obtainable.

Several accidents which occurred recently, during the experimental stages of the invention, have naturally been referred to by those who uphold the ordinary apparatus. These people say that the electrolytic circuit breakers destroy the Crookes tubes and damage the induction coils. Mr. McIntyre has reduced these assertions to their true value. He says that the new method permits the tubes and coils to perform the work done by much larger ones before this revolution in radiography. He also combats the assertions of these enthusiasts by declaring that much larger tubes will be needed, and that the size which they will be made will depend entirely upon the service required of them.

M. Radiguet is now having made the largest tubes that the most skillful workmen can blow. His ambition is to have tubes nearly six feet in length, so that in one second he can take a full-length radiograph of a person and inspect his internal organs at the same time. This new apparatus will have many uses; for instance, it can be employed in the radiography of conscripts who appear before a commission with a view of being excused from service in the army on account of real or alleged disabilities. Other branches of electricity will also profit by the new discovery. The coil in its simplest form becomes an incomparable transformer for alternating currents. Electro-chemistry will certainly take a lion's share of the applications of this invention. The Woehnelt apparatus can be applied to all kinds of transformers. The Masson-Ruhmkorff induction coil will cease to be simply a laboratory instrument and will become of practical use. —W. De Fonvielle in Cosmos.

In the current number of the SCIENTIFIC AMERICAN we give an interesting account of experiments with the interrupter by Prof. R. K Duncan.

THE ORIGIN OF EGYPTIAN CIVILIZATION.

AT the last meeting of the anthropological division of the British Society of Natural Philosophy, Prof. Flinders Petrie gave a very interesting review of his investigations during the last five years. At different excavations in Koptos, Naquedeh, Abydos, and Hieraconpolis, relics were found dating back beyond the year 4000 B. C., usually taken as the beginning of known history.

At Naquedeh primitive remains were found which Petrie was at first inclined to assign to a new race; but he now considers them sure signs of a primitive race of Libyan stock with a slight mixture of negro blood. Traces of such a race can be followed beyond the first Egyptian kings, from the time of Mena to about 5000 B. C. In the tombs of this primitive race vessels of black clay were found upon which curious characters were impressed. Between this people of 5000 B. C. and that of 4000 B. C. a greater difference in civilization is noticeable than between the latter people and the modern Egyptians.

Petrie then spoke of the remains of the old dynasties, of the probable tomb of King Mena, the founder of the historical dynasty, which began 4700 B. C., and of the tombs discovered at Abydos belonging to the kings of the first three dynasties. The gradual substitution of stone implements and weapons by those of metal, which first appears in the employment of copper and afterward of bronze, and which took place between 4500 and 1500 B. C., is not equaled anywhere else in the world. Seals and impressions therefrom, vases—among which was one covered with the oldest mythological characters—tablets and sculptured works picturing men and animals of the time of the first three dynasties were exhibited. These relics show the beginnings of the plastic art of that time and prove the astonishing fact that Egyptian art in the representation of animal and human life reached its highest development some time before 4000 B. C., and later degenerated into a mere schematic representation of life. The relics also show the old kings triumphing over their foes, receiving the homage of captive kings, dedicating public buildings and works, filling in swamps, and the like. Copper kettles constituted the chief metal utensils of the first three dynasties. The people of historic times appear, from these relics, to have been very different from the primeval Egyptian race. In the opinion of Prof. Petrie the development of art, letters, and civilization in Egypt is different from that of most other lands, in so far as it is original and not borrowed.

To follow the development of Egyptian art, says Prometheus, from a time in which the inhabitants of the Nile Valley ate the flesh of their ancestors (from all appearances because of religious motives, for the bones in the oldest tombs are cleaned and carefully tied in bundles) to that higher civilization which flourished in Egypt as early as 5000-6000 B. C., is like watching the unraveling of a great drama.

Nimes, the birthplace of Alphonse Daudet, is going to erect a monument to the immortal author of "Tartaran" and is raising part of the money by bull fights.

ELECTRICAL NOTES.

"When I visited America in 1884," said Mr. W. H. Preece, of London, in a recent address, "there was only one experimental electric railway line at work, in Cleveland, O. Now there are more miles of line so worked in Cleveland alone than in the whole of the United Kingdom."

The installation of electric light in the Vatican was recently inaugurated, and consists of an installation of about 6,000 lamps. According to a Reuter's telegram, the Pope remarked that "people will no longer be able henceforth to reproach the Vatican with being the enemy of light."

Experiments are about to be made with Marconi's system of wireless telegraphy across the Straits of Messina, between Reggio and Messina, and the Elektrotechnischer Anzeiger hears that if these are successful they will lead to a regular wireless telegraph service being established between the two points.

Electrically driven deep well pumps are to be used during the coming season in Kern and Tulare Counties, California, says The Engineering Record. In the latter county the Mount Whitney Power Company, of Visalia, will install a plant on the Kaweah River, where three Westinghouse generators of 600 horse power each will produce current for use at wells near five towns some distance apart, as well as for lighting and power purposes. Steam plants have been used successfully at irrigating wells for a number of years, and it was this fact which prompted the company to install small motors for the purpose.

According to the Industrie Electrique, the Paris, Lyons and Mediterranean Railway Company is about to construct an electric railway from Saint-Gervais-les-Bains to Chamonix, at the foot of Mont Blanc. It will be a meter-gage line, intended both for passengers and goods. The current will be collected from a side rail, and a rack and pinion will be employed where the gradient is steep. The river Arve will furnish the necessary energy, partly from the station already existing at Chedde and partly from three other power houses which are to be built. The line is about 12½ miles long and crosses the Arve several times.

The electric lighting apparatus used in the plant at Bulawayo was shipped from New York, and carried by rail to Mafeking and in bullock carts to Bulawayo. During the transit the Matabele war broke out, and all the small wire which had been delivered was seized by the Bulawayo authorities and used for powder mines in the approaches to the town. The glass insulators while in the bullock carts were captured by the Matabele natives, and were suspended from their necks. This, says The Electrical Review, of New York, necessitated the replacement of considerable material, and two years were occupied in erecting the plant.

Prof. Andre Blondel has a most ingenious instrument for the measurement of hysteresis of iron. It consists of a horseshoe magnet adapted to be turned about a vertical axis by a handle and gearing. There is also a delicately pivoted axis carrying at its top a support for holding a cylinder of punched rings of the metal to be tested and the index which plays over the scale. On the lower part of the vertical pivot of the apparatus is a helical spring. When the handle is turned and the magnet spun round, there is a corresponding tendency for the bundle of rings to turn in the same direction. Readings are taken by swinging the magnet through one complete revolution slowly or rapidly.

The Street Railway Journal has, in its February number, a useful table of street railway statistics for the United States and Canada for the year ending December 31, 1898. Thus we see that at that date there were 15,672 miles of electric lines in use, an increase of almost 2,000 miles on the previous year. The number of motor cars had increased during the same time from 29,659 to 36,429. It is interesting to note under the columns of "cable railways," also included in the tables, that there is a decrease in the mileage from 539 in 1897 to 460 miles in 1898. The horse railways show even a larger percentage decrease. At the end of 1898 the total amount in capital stock and funded debts of the various street railway undertakings in the States had reached the enormous total of $2,000,000,000.

The Washington correspondent of The Western Electrician writes as follows: "It is gratifying to observe that American electrical manufacturers have learned the significance of our industrial opportunity, and it may be assumed that the conditions of export trade are now being studied by every manufacturer who is confronted by the problem of finding new outlets for his productions. This fact is illustrated by official statistics, which show the rapid expansion in our export trade in electrical machinery. According to these figures, the exports in this line in 1897 were valued at $917,453, while during the year just passed the exports reached the value of $2,523,644, a net gain of $1,606,191 in twelve months." It is to be noted, too, that telephones, telegraphs, and "other electrical equipment" are given a separate classification in the government reports.

A Swedish inventor has patented an addition to the log, by which its readings may be directly shown in the chart-room or conning tower. Only a brief description of the apparatus is here given. It may be said that the instrument is connected by means of an electric cable to a contact mechanism giving a suitable number of contacts per mile to the part of the instrument that points out the distances on a dial graduated in miles. This contact mechanism can be attached to an ordinary taffrail log, and set in motion thereby. According to the invention, a mark is made at the side of a tape for each hour, and in the middle of the tape each mile run is marked out by a dot, so that it can be seen how many miles in a certain hour have been run with more or less speed than usual. The instrument points out the miles exactly according to the taffrail log; it registers the miles per hour, and gives, if desired, a signal on an electric bell when a certain distance has been traveled.—Shipping World.

MISCELLANEOUS NOTES.

In his treatise on in-breeding and crossing in man ("Inzucht und Vermischung beim Menschen," Leipzig, 1897), Dr. Albert Reibmayr brings much erudition to bear upon an old problem, the respective roles of in-breeding and crossing. Close in-breeding is necessary to fix and ennoble a race, but when it is prolonged, or if the material be poor, there is continual risk of weakness, infertility, and degeneration. But it is through in-breeding that a national character is evolved, and the problem of national eugenics is to watch for the crisis when crossing becomes necessary to obviate degeneracy. Thus in history there have been and must be alternating periods of dominant in-breeding and dominant cross breeding. In America, the author indicates, a new race is being formed by complex cross breeding, a new race which will lead mankind to new ideals in spite of the reactionary doctrine "America for the Americans." And behind this prophecy—which is always rather gratuitous—there is no small amount of solid anthropological measurement and statistics.

In order to guard against accidental breakage of glass in an ordinary miner's lamp, Mr. Max Raphael, of Breslau, Silesia, has constructed a cylinder of double plates of mica, each of which have their vertical edges united in metal to form a secure joint. The smaller of the two cylinders is inclosed within the larger, and thus leaves a small annular air space of about ¾ of an inch wide between. The two vertical joints coincide so as to intercept as little light as possible, although this may be a disadvantage as regards strength of construction. The two cylinders are kept in position, top and bottom, by being inserted into two brass rings, having annular rims, the edges of which are turned toward one another. The grooves thus formed contain some red lead cement, in which the edges of the mica cylinders are embedded, thus insuring air tightness. When thus formed, the double cylinder is let into the lamp cage to replace the usual cylinder of glass. Lightness is one of the advantages claimed for this arrangement, and less liability to breakage, which, in the case of glass lamps, is a serious matter in the presence of inflammable gas and coaldust. For, even if the outer cylinder should by any chance be fractured by a knock, the inner one would, in all probability, remain intact. It must be allowed that these advantages are not gained without a slight diminution of light as compared with glass, for mica is not quite so transparent; but this objection will not weigh seriously where increased security against explosion is considered.

The report of the New York State Insurance Commissioner shows that 122 of the fire and fire-marine insurance companies of this country and foreign fire insurance companies of other countries, United States branches, doing business in New York on December 31, 1898, received $9,130,892 more than they disbursed, and 49 companies disbursed $1,450,609 more than they received. The disbursements were $132,338,978, which was $14,523,675 more than in 1897. The 185 fire, fire-marine, and marine insurance companies at the close of the year were covering $20,216,898,434 of risks in force. During the year these companies, with the exception of the New York mutuals (8), for $181,200,372 in gross premiums undertook to carry $20,451,817,459 of risks, an average premium of 0·89 for every $100 insured. By these companies $137,045,777 was received in premiums, $80,447,509 was paid for losses, $52,225,189 for expenses, and $7,163,782 for dividends. The fire premiums received last year by joint stock fire companies of New York and other States and countries and by the mutuals of New York and other States were $19,864,031; fire losses paid, $10,041,904; fire losses incurred, $11,312,776. The estimated amount of expense for the transaction of this business is $6,620,532, which, if added to the incurred losses, makes a total of $17,933,309, showing, as compared with the premium receipts, an apparent net excess of fire premiums received over fire losses incurred and estimated expenses of $1,928,286. The amount of fire risks written in 1897 was $3,625,411,110; in 1898, $3,830,230,868, an increase of $204,819,758. The amount of marine and inland risks written in 1897 was $507,118,954; in 1898, $539,231,482, an increase of $32,112,528.—Bradstreet's.

This table, taken from a British consular report, relates to the world's production of coffee and the price obtained for the quantity named at Havre, France, during each of the periods set forth:

PRODUCTION OF COFFEE.

	Bags of 60 Kilos (132 lb.)		
Crop.	Brazil.	Other Countries.	Totals.
1874–75	3,843,600	4,295,400	8,139,000
1875–76	3,505,800	3,679,200	7,185,000
1876–77	3,294,000	4,520,000	7,814,000
1877–78	3,498,200	4,017,800	7,516,000
1878–79	4,718,000	4,200,000	8,918,000
1879–80	3,172,000	5,413,000	8,585,000
1880–81	5,553,000	4,205,000	9,758,000
1881–82	5,562,000	4,829,000	10,391,000
1882–83	6,711,000	5,369,000	11,080,000
1883–84	5,056,000	4,711,000	9,767,000
1884–85	6,211,000	5,229,000	11,440,000
1885–86	5,532,000	3,956,000	9,488,000
1886–87	6,129,000	4,183,000	10,312,000
1887–88	3,006,000	4,071,000	7,077,000
1888–89	6,735,000	3,863,200	10,598,000
1889–90	4,220,000	4,438,200	8,658,200
1890–91	5,308,000	3,989,000	9,297,000
1891–92	7,376,000	4,482,000	11,858,200
1892–93	6,193,000	5,090,000	11,283,000
1893–94	4,307,000	4,895,000	9,202,000
1894–95	6,689,000	4,947,000	11,636,000
1895–96	6,250,000	3,944,000	10,194,000
1896–97	8,680,000	3,928,000	12,608,000
1897–98	11,110,000	4,600,000	15,710,000

"The lighting of a room," says The Pharmaceutical Era, "depends, to a large extent, upon the color and the material of the walls; in other words, upon the percentage of light reflected by them. Recent experiments have shown the proportion of light reflected to be in percentages as follows: Black velvet, 0·4; black cloth, 1·2; black paper, 4·5; dark blue, 6·5; dark green, 10·1; light red, 16·2; dark yellow, 20; blue, 30; light yellow, 40; light green, 46·5; light orange, 54·8; white, 70; mirror, 92·3."

SELECTED FORMULÆ.

Liquid Disinfectant.—What is ordinarily meant by a disinfectant for use about the house is a deodorizing antiseptic. Copperas, on account of its cheapness, is most frequently used, and is efficient. It has one especial recommendation in its cheapness. The fault found with it is, that it produces rust stains and unsightly discolorations wherever it is used. This does not interfere with its usefulness in stables, outhouses, drains, etc., but is an objectionable feature. Salts of alumina, especially the sulphate, answer the purpose better for use about the house, but are, of course, somewhat more costly. A strong solution of chloride of zinc, prepared by dissolving scrap zinc, or zinc oxide, to saturation in muriatic acid, is of much greater intrinsic value as a disinfectant, and on the whole is probably the best thing to recommend. The only objection to it is that it is poisonous, and it should never be sold without a poison label. Among the disinfectants said to be especially useful in destroying foul odors is thymol, which may be most conveniently used in the form of an alcoholic solution, to be employed with a spray apparatus.

Here are a number of typical formulas:

HOUSEHOLD DISINFECTANT.

Iron sulphate	8 ounces.
Ammonium chloride	1 "
Corrosive sublimate	1 drachm.
Alcohol	4 ounces.
Water, to make	32 "

Dissolve the iron sulphate in 24 ounces of water and the corrosive sublimate in the alcohol. Mix both solutions, add the ammonium chloride and enough water to make 32 ounces. Mix with equal parts of water, and use as a disinfectant.

SOLUTION OF FOUR CHLORIDES.

Alum	10 ounces.
Sal soda	10 "
Sal ammoniac	3 "
Common salt	2 "
Chloride zinc	1 "
Muriatic acid, commercial, q. s.	
Water, quantity sufficient to make	1 gallon.

Dissolve the alum in ½ gallon of boiling water, then add the sal soda, which gives a precipitate of aluminum hydrate. Muriatic acid is then added in sufficient quantity to dissolve this precipitate, thereby forming aluminum chloride. The other salts are then dissolved in the remainder of the water and added to the first solution. The advantages claimed for this preparation are cheapness, ease of preparation, odorless, non-poisonous, and its adaptability for general use. Its freedom from iron, in the disinfection of clothing, is an important point, insomuch that it will not injure the fabric in any way.

LIQUID DEODORANT FOR WATER CLOSETS.

Ferric chloride	4 parts.
Zinc chloride	5 "
Aluminum chloride	5 "
Calcium chloride	4 "
Manganese chloride	3 "
Water, sufficient to make	90 "

Dissolve, and add to each gallon 10 grains thymol and ¼ ounce oil of rosemary, previously dissolved in about 6 parts of alcohol, and filter.

DISINFECTING FLUID FOR SICK ROOM.

Guaiacol	50 grammes.
Eucalyptol	40 "
Menthol	20 "
Carbolic acid	30 "
Thymol	10 "
Oil clove	5 "
Alcohol, q. s.	1,000 "

To be sprayed about with water.—Pharmaceutical Era.

Freckle Lotion.—

(1)	Borax	2 ounces av.
	Potassium chlorate	1 "
	Glycerin	4 fluid ounces.
	Alcohol	2 "
	Rose water	10 "

Mix the borax and chlorate of potassium with the glycerin and rose water; when as much as possible is dissolved of the salts, add the alcohol and filter. Directions: Apply with a soft sponge several times a day.

(2)	Corrosive sublimate	10 grains.
	Spirit of camphor	4 fluid drachms.
	Spirit of lavender	4 "
	Rose water	5 fluid ounces.
	Water	10 "

Dissolve the mercuric chloride in the spirits and add the same to the waters. Directions: Apply at night and wash off in the morning; after a few applications, roughness of the epidermis is produced, which peels off, and the skin should be anointed with some cold cream ointment.—Meyer Brothers Druggist.

Lubricant for Glass Stoppers and Stop Cocks.—F. C. Phillips reports (Journ. Am. Chem. Soc.) that he finds the following a good lubricant for glass stoppers, etc.:

Pure rubber	70 parts.
Yellow wax	30 "

The rubber should be pure and fresh. Old rubber or scraps of worn-out tubing, whether black or red, will not answer as well, and may cause the mixture to become more or less granular and opaque when used in stop cocks. The rubber is best heated in a covered vessel until thoroughly melted, and then the wax should be added. The hot mixture is well stirred. This lubricant is very serviceable, protects stop cocks from sticking, even when used for concentrated solutions of caustic alkalies, and is quite translucent in thin layers. Care should be taken not to scorch the mixture in its preparation. Strong alkalies tend in time to loosen and emulsify all lubricants, and the stop cocks should occasionally be cleaned and recoated. The mixture above mentioned may be readily removed from parts of glass apparatus which are difficult of access for cleaning by the use of a little concentrated nitric acid, which quickly attacks and loosens it so that it may be washed out by water.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

United States Trade in West Africa.—Acting Consul Trice sends from Sierra Leone, under date of January 26, 1899, copies of letters to commercial firms in the United States, from which the following information is taken:

West Africa presents an excellent field for the extension of American trade. Men willing to give personal attention to the diversified requirements of the coast are needed. Trading here is not exactly like trading in America. The British, Continental, and native firms here might be induced to deal more in American produce and manufacturers, and in this way benefit would accrue to our exporters; but it would be much more profitable to establish American firms on the coast capable of maintaining a supply adequate to the great demand for United States goods. There is one American firm in this city that has done excellent service in the past, and to it is due the credit of having created the present demand; but the market is so large that there is a good opening for others. American goods are in demand all along the coast. There is a growing realization of the need of a line of steamers direct between the United States and the west coast. The advantages our country would realize through such a medium of communication can be seen at once, when it is noted that scores of prominent native merchants visit Europe annually, making trade alliances. There is a demand for an extension of commerce with the United States, and this would be most effectively promoted, I think, by the establishment of a line of steamers.

Hemp-Working Machinery in New Zealand.—In reply to instructions directing me to report regarding a bonus, or prize, offered by the New Zealand government for an improved Phormium tenax machine for the native flax of this country, I beg, says United States Consul Dillingham, of Auckland, to state that this matter has been thoroughly investigated by me, and several letters have been written to parties in the United States who have asked for information. I am told that the time has lapsed during which the bonus for improved machinery for working hemp was offered, but (semiofficially) I am informed that any one able to furnish a really satisfactory machine or method for dressing flax could very likely make such terms with the New Zealand government as would lead to his receiving an equivalent of the bonus originally offered.

I do not think it will be worth while to attempt to lay down New Zealand hemp in a raw state in any American city, because I believe it takes about seven tons of the raw material to make one ton of the dressed; and I, therefore, unless the article could be dealt with here, I think there would be poor prospects of building up a trade.

Under date of November 1, 1895, the Department of Agriculture for New Zealand issued a notice (No. 430) for a bonus of £1,750 ($8,516) for a machine or process for dressing New Zealand hemp (Phormium tenax) which should be an improvement on the machines or processes then in use, and which should, at the trial, be found to materially reduce the cost of production, improve the product, or increase the quantity of dressed fiber. All applications were to be addressed to the Minister for Agriculture, Wellington, to reach him not later than December 31, 1897. They were to be accompanied by a description, particularly stating improvements on present machines or processes, and also the cost at which the machine or process could be supplied; the machine or process was to be submitted to examination, at such time and place as the government might direct, to a committee of three or more experts. The cost of bringing the machine or appliances to the ground from within the colony, supplying the necessary shafting, motive power, and buildings, was to be defrayed by the government; and, if any machine was sent from beyond the colony, and was awarded the bonus or part thereof, the cost of bringing the same was to be borne by the government. The committee was to supply a sufficient and equal quantity of green hemp to each machine or process as a test; also, to take into consideration the time occupied in the operation, the cost of labor, and time required after the fiber had left the machine or process before it was ready for baling, the percentage of dressed fiber or tow produced by each machine or process, the cost of producing the same, the cost of the machine, and the simplicity and durability of the working parts. On completion of the test, the committee was to furnish a report to the minister, etc.

The bonus (No. 2) of £350 ($1,217) was offered for a process of utilizing the waste products of the hemp.

Up to this time, no machine or process has been found which, in the opinion of the committee, seems to comply with the requirements.

United States Wagons and Agricultural Machines in Germany.—It is beyond doubt that American dealers in agricultural implements and wagons of all kinds could, with proper effort and understanding of existing conditions, have far more business in this section of the German empire than at present. True, our present trade with this country is not inconsiderable; but it is my conviction, says United States Consul Diederich, of Magdeburg, that in many instances the American goods sell themselves, in spite of the American merchant and manufacturer.

The province of Saxony, of which Magdeburg is the capital and center, forms one of the most important and extensive agricultural districts of the German empire, and therefore affords a splendid field for the American manufacturer of agricultural implements. But the chief difficulty met by the German importers in introducing American machinery of this kind is their entry in the German custom house. It is not generally known that there are no national administrative laws for the German custom houses, but that each state or province is governed by laws of its own; and it might be well for American manufacturers and exporters to always make sure of their ground in this respect, before undertaking to make shipments.

A German importer of agricultural machinery in Magdeburg informs me that he has all machines shipped to him knocked down and crated, and then has the different parts put together here. When American mowers and reapers are supplied with an extra knife, this is not classified as a part of the machine by the custom house, but is subjected to an extra high rate of duty—the "cutlery rate." Since it is a part of a machine which consists chiefly of cast iron, it should properly pay only 3 marks (71·4 cents) per 100 kilogrammes (220·46 pounds). Owing to the gloss of the American oil paint, horserakes and other farmers' implements are apt to be entered as "lacquered ironware," at the rate of 10 marks ($2.38) per 100 kilogrammes. It was only after a great deal of explanation, my informant tells me, that he succeeded in having this sort of machinery passed at 5 to 6 marks ($1.19 to $1.43) per 100 kilogrammes. The rate of duty on reapers with binding attachment varies in the different custom houses. In some cities, 3 marks (71·4 cents) per 100 kilogrammes are demanded; in others, 5 marks ($1.19) per 100 kilogrammes. I will add that crates, boxes, etc., protecting the machinery are weighed with the same, and are subject to the same duty.

Considerable difficulty in importing American machinery is also encountered, because, as yet, not sufficient attention has been given to the wants of the German market. It is absolutely necessary that American manufacturers should study the needs of the people here, and then, I feel confident they will, in most instances, be able to enter into competition with concerns in Europe. Not long ago I saw in a warehouse a large stock of mills for grinding feed. Upon closer inspection, I found all the machines to be of English make, and when I inquired whether or not American mills were being imported, an object all begrimed and dusty in a remote corner was pointed out to me, which I found to be an American feed mill. When I asked what this meant, I was simply told that "the American work is much too light for this country."

American farm wagons and other vehicles might also find more extensive sales in the markets of Germany, if more attention were given to the matter. In order to protect the highways, the laws demand that the tires of wheels be much wider than they are in the United States. American manufacturers, until now, have shown no inclination to consider this fact. I know of an instance where a German importer ordered from an American house a few wagons with broad wheels, such as the laws of this country require, but the reply sent to him was that if he would order a thousand wagons, the width of the tires would be made as requested. Of course, the order was not given. This can hardly be called an effective way of introducing American goods. For Germany and for most countries of Europe, the wheels of carts, buggies, and other light vehicles should be from 2 to 2½ inches wide, while the tires of farm wagons and trucks should be from 3 to 4 inches in width.

In shipping wagons of all kinds, it must be borne in mind that every vehicle which is entered at the custom house must pay 150 marks ($35.70) duty when put together and all complete; but when knocked down and crated, a much lower rate is demanded, viz., 10 marks ($2.38) per 100 kilogrammes. However, the lower rate can only be secured when no leather is to be found on or about the vehicle. Nor should the leather parts of any vehicle be shipped in the same case, for, even if a separate bill of lading be presented, the presence of the leather parts in the same cargo will have the effect of changing the classification of the vehicle.

Another mistake made by many American manufacturers and dealers is that they attempt to extend their business in foreign countries by flooding them with printed, illustrated, and descriptive catalogues and circulars, and, of course, in the English language. That money so spent is worse than wasted, goes without saying. A great deal more could be accomplished by sending abroad commercial agents and traveling men fully familiar with the language and business customs of the people of this country. In my judgment, the most effective way to sell American tools and implements and wagons and machinery of all kinds would be to exhibit them here in public, and to have their uses practically demonstrated by live agents.

Because of the great and ever-increasing scarcity of farm laborers in Germany, there is a growing demand for substantial, practical farming tools and machinery; and American manufacturers now have an excellent opportunity for an increased sale of their goods in this line, if they will but make thorough, systematic, and businesslike effort.

Communication with the Philippines.—The following, dated Sydney, February 7, 1899, has been received from Consul Bell:

I would report, for the possible benefit of our traveling or commercial people, that three steamship lines, plying between Australia and China and Japan are now calling regularly at the port of Manila, Philippine Islands. These are the China Navigation Company, the Eastern and Australian Steamship Company, and the Nippon Yusen Kaisha (a Japanese line). Each of the companies has four fairly good and well equipped steamers, averaging 2,500 tons, and, as each line makes monthly trips, there is a call at Manila about once in ten days from Australia, and from Chinese and Japanese ports. These are not new lines, but their regular call at Manila has been arranged since the islands came into our possession. There is already considerable business, both in freight and passenger traffic, between Sydney and Manila, and there is great confidence in shipping circles that the trade will soon become very important.

The United States in the World's Markets.—Under the above title, the organ of the Industrial Union, one of the most powerful organizations of the empire, has just published an article as interesting to American merchants and manufacturers as to those of the fatherland. I may add, says Consul J. C. Monaghan, of Chemnitz, by way of parenthesis, that the Industrial Union exercises an enormous influence all over the empire, gathering statistics, preparing data, giving counsel when trade treaties with foreign countries are under consideration, etc. The article begins by calling attention to the wonderful work being done by the United States to win first place in the world's markets. It says, in part:

"The United States is essentially ahead; it is only in the total of imports and exports that we show greater returns. Its exports are ahead of ours. In the last fiscal year (June 30, 1898), the exports of manufactures reached $290,000,000; and, although agricultural products, as usual, were well represented, the increase in the exports of manufactured articles was considerable and comparatively greater.

"The increase in iron and steel literally borders on the marvelous. In thirty years, the value of these exports has gone up tenfold. The increase in the exports of copper wares is, comparatively, still greater. The exports of leather and leather goods more than doubled in the last ten years. Cottons have gone up slowly; only 50 per cent. in twenty years. Bicycles, the exports of which began only ten years ago, now almost equal the exports of agricultural implements, which, in thirty years, increased upward of tenfold, and in the last ten years threefold. The falling off in the sugar exports is not to be put down to a decline in the American industry, but to artificial aids in the form of premiums, which increase the European export. The increase in quantities exported is greater than the increase in values, since prices have constantly fallen during the last thirty years. The exports in mineral oils show a gain of 150 per cent. in value, but of 1,000 per cent. in quantity. This is doubtless true, perhaps not in the same percentage, of other articles. The showing is full of stuff for earnest thought for Germans."

In the growth of American exports, Europe will see itself forced to competition never counted on before in its widest calculations. With Nicaragua's canal cut, with cotton mills turning off cheap cloths beside the plantations in the South, with iron and steel works in Alabama, Pennsylvania, Ohio, etc., alongside the coal mines, with our wonderful natural waterways improved, there is no reason why we should not go on in the twentieth century as we have during the last two or three decades of the nineteenth.

Opening for Stone Crushers in Germany.—Our manufacturers of stone-crushing outfits, tile ditchers, and sewerage apparatus would, in my opinion, find a market in Germany. This empire has, perhaps, the best system of country roads in the world. Not only are new roads being continually built, but the old ones are repaired every five years. The stones are all crushed by hand with sledge hammers. From the car windows one can see piles of stone extending for miles along the roads, waiting for the workmen to commence the long and tedious task. In many of the stone quarries one can see huge piles of uncrushed stone ready to be carted away. An American steam stone crusher would accomplish marvelous things if set up in one of the quarries.

The best method for an American manufacturer, if he wishes to introduce these machines into Germany, is to secure a contract from the government, either state or municipal, to do a certain amount of work for a definite sum of money. Nobody will buy these machines without having first seen their utility demonstrated.

Ditchers and sewerage apparatus might be introduced into the Prussian provinces, where the soil for the most part is sandy and no rocks would be encountered. Considerable irrigation is also carried on.—Ernest L. Harris, Consular Agent, Eibenstock.

Shoe Trade of Hawaii.—Consul-General Haywood, of Honolulu, on February 28, 1899, sent the following report:

All boots and shoes are imported from the United States, with the exception of Chinese shoes and slippers, which come from China. The importations for the year 1898 were:

From United States	$172,931 93
Great Britain	52 54
Germany	39 10
China	7,174 04

There are no manufactories here. There are some Chinese who make shoes to order, but their output is very small, being confined principally to a poor quality of white canvas shoes.

Electric Road in Breslau.—Consul Erdman writes from Breslau, January 9, 1899:

I wish to inform our manufacturers of and dealers in street-car rails, electric motors, wire and electric supplies, that the street car company of this city, which has been using horse power, has been granted the privilege by the city authorities to employ electric motive power at the expiration of its present charter, which will be in 1902.

Steel Butt Hinges and Hardware Wanted in England.—Consul Marshal Halstead, of Birmingham, on February 23, 1899, writes that he has an inquiry from a firm of hardware merchants in a market town of 34,000 inhabitants, for the names and addresses of manufacturers of "patent American steel butt hinges" and the names of any makers of builders' ironmongery. The firm says: "We have come across a quantity of American hardware in this district, and would like to communicate with the makers."

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No. 387. March 30.—*United States Wagons and Agricultural Machines in Germany—Collection of Debts in Guatemala—Agricultural Conditions in Paraguay—Telegraph Line to Dawson: Temperature in the Yukon—*Shoe Trade of Hawaii—Copra in Samoa: Freight Rates from America.

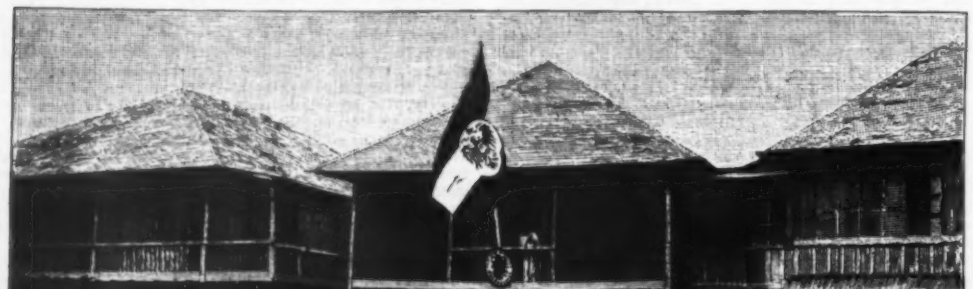
No. 388. March 31.—Notes from the Yukon—*The United States in the World's Markets—Motor Carriage Exposition at Berlin—Malt Liquors in Antigua—Tariff Changes in Antigua—Canadian Tariff Changes—*Machetes in Paraguay—Expositions of United States Goods in Russia.

No. 389. April 1.—Agricultural Products of Siberia—The Russian Cotton Market—*Opening for Stone Crushers in Germany—Electric Street Railroads in Germany—*Communication with the Philippines—Exports from St. Gall to the United States—Preservation of Rubber Trees in Congo Free State.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

CAPTURE OF ILOILO.

ILOILO, of which we have heard so much recently, is the chief town of the Visayas, on the island of Panay, and lies on the south coast of the island, on a narrow channel which separates Panay from Negros, and it is rendered still narrower in the middle by the island of Guimaras. It rejoices in a good natural harbor and has a brisk trade with Mindanao. Several German firms in Manila have branches there, and there are also English and Swiss business houses in the place. Iloilo is an open city and is protected from attack only by a fort.



THE IMPERIAL GERMAN VICE-CONSULATE AT ILOILO.

On December 18, 1898, Gen. Miller was ordered by Gen. Otis to set out for Iloilo, which was still in the possession of the Spaniards, with an expedition consisting of infantry and artillery. Before Gen. Miller reached his destination, the Spanish commander, Gen. Rios, left Iloilo on December 24 with his troops and collected his entire force in the southern Philippines, at Zamboanga in the extreme southwest of the island of Mindanao. On December 26 the insurgents entered Iloilo, inaugurated a government, and placed a guard to protect the property of the foreigners. The United States troops did not reach Iloilo until the 28th. The insurgents erected barricades in the streets of the city and made every preparation to resist the attack of Gen. Miller. The foreigners took refuge on the British cruiser "Bona Ventura." Gen. Otis sent reinforcements and Admiral Dewey sent the "Concord" and "Petrel." Gen. Miller landed on the island of Guimaras before Iloilo to make his preparations for the seizure of the place. The situation then became an anxious one. The insurgents had entirely occupied the city which the Spaniards had evacuated and were not disposed to allow their position to be forced by the American army and navy authorities. The lesson which the Tagals received on the outskirts of Manila served to render the capture of Iloilo much easier than it would otherwise have been. The Visayas knew the importance of Iloilo and had assembled a large army of several thousand men to defend it. The forces of Gen. Miller included the 18th U. S. Artillery, the 51st Ohio Volunteers, Battery G, 6th U. S. Artillery, the 1st California Volunteers and the 1st Tennessee Volunteers. There were several foreign men-of-war, including the German cruiser "Irene." It is said that the authorities of the latter ship said that if the United States forces were withdrawn, the "Irene" would land her men and take possession in the name of Germany. The peaceful attitude adopted by the United States forces continued so long both at Manila and Iloilo that it did not impress the natives favorably. They cannot understand conciliation, and when attempts to placate the natives and avoid bloodshed are made, it is considered to be only cowardice.

On the arrival of the "Newport" with Gen. Miller, the insurgents sent a committee to the general to ask him the reason of his presence. He postponed answering them until the next day. They took advantage of the delay to gather from the hills outside the town of Jaro 16,000 men who were waiting for the call to assemble, so that when Gen. Miller sent a reply he found that they had profited by his delay to land his men, and, in response to his proposition to land his troops, made reply that a peaceful reception could not be guaranteed without first consulting Aguinaldo. Gen. Miller promptly refused to consent to the delay, whereupon the insurgents stated that when our forces landed their safety could not be promised. Preparations were then made to land the men from the transports, and a number of boats were in the water at the gangways and the men were preparing to fight when the recall was sounded. The reason of this was a petition from the foreign residents of the town to the effect that no American troops be landed until Aguinaldo had been heard from and until the Americans had formally taken possession of Manila. Gen. Miller acceded to this request, which was unfortunate, as even then the landing could probably have been made peacefully had it been essayed. It was found that the natives had made preparations to fire the town in several places. They had also made earnest efforts to prevent the United States from getting control of the river and succeeded in sinking several lighters in the mouth of the river, thus closing it. They also put out the light used as a beacon by entering vessels. It was not thought desirable to bombard the city until the peace treaty was ratified. After the events at Manila, February 4, 5, and 6, and after the news of the ratification was received, word was sent to Gen. Miller by Gen. Otis to give the natives an ultimatum, by the terms of which they were to evacuate Iloilo before the evening of the 11th, on the penalty of bombardment and assault. Twenty-four hours' notice was given by Gen. Miller that he would occupy the city, using force, if necessary. In the meantime the insurgents were warned that, if they were detected in any hostile movement, such as strengthening their defenses, the warships would open fire on them. This warning was unheeded, and the cruiser "Boston" and the gunboat "Petrel" began shelling the enemy's position. A force of forty-eight sailors from the "Boston" was landed under fire of the warships' guns, and took formal possession of the town. When the sailors landed the insurgents began evacuating, after setting fire to the town, moving toward Jaro. When the sailors reached the fortifications which had been held by the insurgents they found them deserted, but the Philippine flag was still flying; they took this down and then proceeded to the governor's palace, where the Philippine flag was also flying. The Americans lowered this flag and hoisted the Stars and Stripes in its place.

After landing the sailors, Gen. Miller's brigades disembarked from the transports and found that the native part of the city had been completely destroyed by fire and the German consulate and former American consulate and two other foreign buildings had also been burned. The banks and sugar warehouses were saved. There were no casualties among the Americans, the enemy firing only a few desultory shots as the soldiers landed. The failure of the insurgents to make a stand did not greatly surprise the Americans. The village of Jaro, a mile north of Iloilo, was captured on Sunday by a battalion of the 18th Infantry. It was learned that the insurgent troops were assembling there, and our troops were dispatched to make a reconnoissance. It was not expected that any serious resistance would be made, but the insurgents held their position for an hour and were finally compelled to withdraw. A few Americans were wounded, but none were killed. Business was at once resumed in Iloilo, and the American forces have since remained in possession.

INNER HARBOR AT ILOILO.

PLAZA ALFONSO XII. AND SOUTHERN PART OF THE CITY OF ILOILO, WITH VIEW OF ISLAND OF GUIMARAS.

[Continued from SUPPLEMENT, No. 1214, page 19469.]

BACTERIA AND THEIR USES.*

IT will not be well for me to close my lecture without saying something about the bacteria which have become disease germs. I say "have become," because we do not know exactly how it was that disease germs started. We do know that we can prove by experiment that certain disease germs may change their character and that their power for evil can be modified in one direction or another. Thus, through the agency or the influence of changes in what might be called their climate or environment, changes of temperature in which they grow or changes in the composition of the culture media on which we grow them, we can make certain species either more or less virulent than they were primarily. So it may be that influences that have been affecting the life history of certain of these species which we now call disease germs may have changed what were originally harmless bacteria into those which are now harmful.

Certain it is that, at the present time, certain species do cause disease, that is, they produce certain symptoms in the animal body in some way or other, which symptoms, taken collectively, we call a disease. Typhoid fever is nothing but a group of symptoms. Another set of symptoms occurring in the same or another person we call diphtheria, and so forth.

Do not forget that there are some diseases not caused by disease germs, but which are due to our own foolishness or misfortune in the way of faulty nutrition, faulty diet, faulty habits of eating or the like. These make a class distinct and separate from those which we call infectious or contagious, and which we now attribute to the bacteria.

How is it the bacteria produce disease? They are not animals, therefore they cannot go around seeking whom they may devour; and we need not try to turn away from them, for they will not eat us up like the lion in the desert. We can take them into our bodies by the drinking of water or with our food, or perhaps in the air we breathe; but they have no malevolence of their own, nor have they any excessive power of motion. Some of them, it is true, have a slight motility, but we have to magnify even this by our microscope to make it really apparent.

We know that some of our higher plants produce substances which are poisonous in certain doses. For instance, the poppy plant produces opium, and from this we get the morphia and other substances which are more or less poisonous. The old-fashioned foxglove gives us our digitalis; monk's hood, our aconite; the jimson weed, of the back lots, a substance similar to bella-

*A popular lecture delivered January 13, 1899, at the Temple College, Philadelphia, by Seneca Egbert, A.M., M.D., Professor of Hygiene in the Medico-Chirurgical College, and of Anatomy, Physiology, and Hygiene in the Temple College, Philadelphia. Revised for the SCIENTIFIC AMERICAN SUPPLEMENT by the author.

donna; and the deadly nightshade itself, belladonna. These poisons or substances from the higher plants we call their active principles. We do not know how the plants produce them; but we know that certain species always produce certain active principles, the quantity of the same depending upon the condition of soil, temperature, and so forth, under which the plant has grown. Practically, the bacteria do the same thing. Where they grow under favorable conditions, they produce their active principles, and these active principles of the bacteria produce the symptoms of poisoning which, collectively, we call a certain disease. In fact, certain of these poisons or active principles produced by the bacteria have been actually isolated from the culture media in which the bacteria have been grown, and, having been introduced into living animals, the characteristic diseases themselves have been produced. It is probably in this way that all the disease-producing bacteria produce disease; and we now have a means of protecting ourselves against all these contagious or infectious diseases by our ability to destroy and prevent the causative poisons. It is for this purpose that we employ our methods of disinfection, which simply aim to absolutely destroy and prevent the further growth of all poison-producing bacteria.

These poisons act as other vegetable poisons do, and it is not improbable that we may eventually actually cultivate some of these special bacteria to produce poisons which we may find are of value as drugs when used in extremely small doses instead of in the amounts which cause such serious results. Thus we consider strychnia a valuable medicine in certain emergencies, although we know that in large doses it is a deadly poison; and so with morphia, aconite, and so forth. At present, the difficulty in the use of the pathogenic bacteria is that their poisons are many times more virulent and potent than even the deadliest drugs from the higher plants.

LANDSCAPE NEAR ILOILO AT SUNSET AND EBB TIDE.

VILLAGE OF SALOG ON GUIMARAS ISLAND.

Thus, the poison of the lockjaw or tetanus bacillus, which produces symptoms almost identical with strychnia, is perhaps fifty times as strong as the latter. It is said that 1/250 grain of this lockjaw poison would probably be fatal to a good sized adult; whereas, we know that 1/10 or even 1/5 grain of strychnia may be taken by the same person without death ensuing.

This leads us to another consideration. We all know that if people get into the habit of taking morphia, cocaine, or any other substance which we call a poison, in large doses, after a time they can take still larger doses by far than at first, without immediate danger; and that eventually they can withstand quantities that would kill a person unaccustomed to the drug. We cannot tell exactly what has happened in their system to enable them to do this, but we know that some change must have occurred to make them proof against such poisons.

A few years ago Ehrlich, acting upon this idea, began experimenting with certain drugs, that is, poisons from higher plants, upon animals. He found that with almost any such poison, by employing gradually increasing doses he could arrive at a point, after a while, in which that which was primarily a poisonous dose would not induce any serious effects in the animal experimented upon.

The first dose (necessarily small) made the animal sick, but it recovered; the next dose produced sickness not quite so marked, and so on, until the animal was not affected by the enormous dose indicated. In other words, the animal had become accustomed to the particular poison, and further experiment tended to show that in the animal's blood had been produced, in some way or other, a substance which had the power to more or less completely neutralize the poison introduced.

Then other observers said: "If we can produce such results with poisons from the higher plants, why can you not do it with the poisons which the bacteria produce?" And considerable work has been done along this line. Two persons working on the idea simultaneously with the diphtheria plant and its poisons, and each without knowledge of the other's work (namely, Behring, in Germany, and Roux, in France), were able to produce a substance in the blood of animals which, in the animal itself or in another animal, prevented any action from the diphtheria poison and which protected such animals against this disease. It has been agreed to call the poisons that the various disease-germs produced, "toxins," and, accordingly, the term "anti-toxin" was given to the substance produced in this way in the blood of living animals.

You must clearly understand that the poisons produced by different disease germs differ as widely from one another as strychnia and morphia, and that each plant produces its own characteristic toxin; therefore, the characteristic anti-toxin is to be produced by treatment with the particular toxin of the disease. As a result of this discovery and development of anti-toxin, we are now able to protect human beings against the ravages of the disease which we call diphtheria; and work is being carried on by many investigators along the same or closely similar lines, having in view similar protection against other diseases.

To make the matter clearer to your mind, I might say that, first of all, the diphtheria bacteria or plants are grown in large quantities in a preparation of beef broth. At the end of a given time they will have not only multiplied enormously, but have produced a very considerable quantity of their toxin or poison, which will remain dissolved in the broth. If, now, this broth be filtered, the bacteria will be removed therefrom and the clear liquid will contain only the poison in solution. If an animal, such as a healthy horse, have now a small quantity of this poison broth injected into his circulation, he will become sick, but will not die. Upon his recovery, in a few days, another injection, a little larger in quantity, will produce symptoms not quite so severe; and at length the time will come when a large injection produces no symptoms whatsoever. If, now, a little of his blood be withdrawn and injected into another animal, it will be found difficult to make that second animal sick by the injection of the diphtheria poison. For convenience of administration, after a horse has been treated in this way, a considerable quantity of his blood is drawn, under strict antiseptic precautions, and is allowed to clot, after which the clear serum which has been found to contain the anti-toxin is siphoned off, so that when the latter is injected into the human being, unnecessary substances may not be introduced into the system. This serum, containing anti-toxin, has added to it a little antiseptic, to prevent any decomposition occurring in it, and then is sealed in closed bottles or bulbs, for distribution and subsequent use. This, in brief, is the whole process followed in the production of the anti-toxin that is now so generally used.

Certainly the history of medicine contains no more brilliant discovery than this one so recent; probably the only thing comparable to it is the discovery of vaccination by Jenner a century ago. You will understand that the whole theory of the action of antitoxin is simply that it neutralizes the destructive action of the poison of the disease germ upon the tissues of the patient. When we say that a child has diphtheria, we simply mean that somewhere in or upon its body the diphtheria plants or bacteria are growing and in their growth are producing the toxin or poison, which, in its turn, is being absorbed and is destroying the tissues of

A VILLAGE ON NEGROS ISLAND.

the child. It is not necessary that these plants should grow only in the throat of the patient; the fact is, they may and often do grow wherever the skin or the mucous membrane has been either destroyed or seriously injured. Physicians have had diphtheritic sores occur even on the back of the hand or other parts of the body (remote from the nose or mouth) where the skin has been broken.

To remove the plants themselves which are producing this poison, and the consequent disease symptoms, may be, and often is, extremely difficult and well nigh impossible; and the disease runs its course, often with fatal results. If we can introduce into the system before much damage has been done some substance that will neutralize the action of the toxin or poison, we, of course, can prevent further extension of disease and save the patient; and such a substance we have in our antitoxin, which is dissolved in the serum administered. It may be that later we shall even separate the antitoxin from the serum produced in the blood of the horse or other animal and administer it in aqueous solution, but at present it is more practicable to not attempt such separation.

This treatment of the dread disease of diphtheria has been in use but very few years—not more than four, at most. In that time most encouraging results have been obtained. From all over the world reports have come testifying as to its efficacy, but it must be used early in the course of the disease to be of benefit; for if the toxin has been introduced in sufficient quantities and has acted long enough to destroy the tissues, the antitoxin has no power to restore or repair the latter. If we can administer it before the second or third day of the disease, great hopes are to be had of success. If its administration does not take place until after the fourth day, the chances are that its employment will be of no avail and that the results of the disease will be practically the same as if it had not been employed.

Not only have individual physicians given their testimony as to the efficacy, but the results obtained from large communities and the statistics that involve an immense number of cases show that there is no doubt, no matter what may be said to the contrary, of the great value of this discovery. The following statistics from the Philadelphia Medical Journal as to the deaths from this disease in Paris, Berlin, and other of the larger German cities prove this beyond a doubt:

Year.	Berlin's Diphtheria Deaths.	Paris' Diphtheria Deaths.	Absolute Number of Deaths from Diphtheria in German Towns of Over 15,000 Population.	Paris' Diphtheria Deaths per 1,000 Living.
1886	1,662	1,512	12,211	6·7
1887	1,303	1,585	10,970	7·0
1888	1,195	1,729	10,142	7·6
1889	1,210	1,700	11,919	7·5
1890	1,601	1,688	11,915	7·3
1891	1,006	1,361	10,484	5·6
1892	1,342	1,403	12,365	5·8
1893	1,637	1,206	16,557	5·1
1894	1,416	1,009	13,790	4·2
1895	987	435	7,611	1·8
1896	559	444	6,202	1·8
1897	546	300	5,206	1·2

You can see from the above table how, up to the end of 1894, there was not in Berlin (which is about the size of Philadelphia) or in Paris (which is larger) a year in which the deaths from diphtheria did not number more than a thousand. From then on they began to fall, although the population of the cities was increasing, until in 1897 in Berlin there were only 546 deaths, where four years before there were 1,416, and in Paris 300 deaths, as against 1,009 in 1894. The figures in the right hand column of the table give simply the deaths (from diphtheria) that occurred to every thousand people who lived in Paris, and refer to said city alone. This shows you that the rate in that city has fallen to about one-sixth of what it formerly was.

In addition to the above, a recent Medical News refers to the use of antitoxin in Chicago for the last twenty-seven months as reported by the Chicago Board of Health. About the first of October, 1896, there began to be a very serious epidemic of diphtheria in Chicago, now one of the largest cities of the world. The Board of Health soon became alarmed and took stringent measures for its suppression; that is, they instituted a thorough inspection of the city and began to inoculate every case reported with the antitoxin except where restrained by the action of foolish persons in families where the disease occurred. From October 5, 1896, until the last of December, 1898, there were reported to the board 5,739 cases of possible diphtheria. Not all cases reported to a Board of Health as diphtheria are diphtheria; and they have to be proved as to their identity by bacteriological test. Of these 5,739 cases, 3,956 were found to be true diphtheria, and all but 134 of these were treated with the antitoxin. Out of the 3,822 patients thus inoculated, 3,563 recovered and only 259 died, that is, only 6·7 per cent. Heretofore, for the entire period of the history of the Chicago Board of Health, they had never been able to keep the death rate from diphtheria in that city below 35 per cent. In fact, almost every text book on the practice of medicine published before 1895 will give the death rate from diphtheria, no matter what the treatment, as necessarily being from 30 to 40 per cent.

Now suppose we should have 35 per cent. of these 3,822 patients who were sick and who were inoculated with antitoxin die. That would have made 1,337 deaths instead of 259 deaths from the disease in Chicago in the last twenty-seven months. There is another thing that is noticeable; if you inject this antitoxin serum into a person who has been exposed but a short time before to diphtheria, he will not get the disease; just as if you vaccinate a person who has been exposed to smallpox, he will be protected for a considerable time against that disease. Formerly, where people lived in the same house with diphtheria patients, or were directly exposed to diphtheria, it was found that almost one out of every two would get the disease; and especially this was true among children. The Chicago Board of Health not only inoculated the 3,822 sick persons mentioned, but they also inoculated 3,633 children and others who did not have the disease but who had been directly exposed to the infection; and of these, instead of 1,800 getting sick, as would have probably happened in the old way, only thirty got sick and not a single one died. Under the old regime, if there had been 1,800 sick, 35 per cent. would have died and then we would have had to add 630 to the 1,337 others; in other words, in the twenty-seven months, through antitoxin, in Chicago, there were saved over 1,700 lives. This is one of the most remarkable evidences one could desire of the value of this discovery; and in cities of over a million inhabitants each, you can easily see what a great advance has been made in the caring for and wiping out of this one disease.

Certainly, there is nothing more brilliant, more hopeful for humanity, than this discovery of antitoxin; and as it is probable, as I have indicated, that similar discoveries regarding other diseases will shortly be made and be practically applied, with results as satisfactory as the above, we should be correspondingly hopeful for the future.

Certain it is that such a saving of human life ought to justify the sacrifice of the lives of many animals which had to be made to bring the discovery to its perfection and safety of application. I know that the statement has been made that the sacrifice of animal life has been of no value, has not saved human life; and the same people say that the deductions are false, and that these statistics are not of value; and yet there has been no change, as far as I know, in the treatment of diphtheria, other than in the use of antitoxin; and there is no other way of explaining the wonderful reduction in the death rate, from what has been one of our most dreadful diseases, than by the assumption that it was due to this discovery.

In regard to the diagnosis of diphtheria in the city of Philadelphia, we have in the City Hall a bacteriological laboratory which is doing a great deal of good work. Suppose a doctor is called in to see a case of diphtheria or probable diphtheria. There are not many doctors that can diagnose diphtheria every time and surely, because, sometimes, mild cases may be overlooked and at other times cases of tonsillitis are erroneously diagnosed as diphtheria. The only way to secure an exact diagnosis is to make a bacteriological test. The bacteriological laboratory supplies a little box, containing a tube of sterilized culture medium (blood-serum) and a sterilized swab (in another tube) to any physician upon application; these boxes may also be had at any time at any of the police stations in the city.

When a doctor is called to a doubtful or suspected case of diphtheria, he accordingly sends for one of these outfits; but, if he is wise, he will probably inoculate the patient with a dose of the antitoxin serum while waiting for the box or, at least, before the test is completed.

When he gets the paraphernalia just described, he puts the swab into the patient's throat, touches the false membrane with it, and then moves the swab around over the surface of the culture medium, puts the soiled swab into its own tube, replaces the plugs in both tubes, and sends the box and its contents down to the laboratory or to the nearest police station, from which there is a collection made twice daily. Upon its arrival at the bacteriological laboratory, the culture tube is put at once into the incubator, which is kept at the body temperature. By the next morning, if there are any bacteria there, they will appear on the surface of the culture medium. The doctors who are there will take a little out, examine it, and determine by the microscope whether it is the true diphtheria plant or not. If it is, they will send at once to the physician in the case a notification of it or, if telephoned, they let him know by telephone; so that he knows positively within twenty-four hours whether it is a case of diphtheria or not and can act accordingly. If it is not, well and good; if it is, he has used the antitoxin in good time; and in that way a great many deaths may be prevented; whereas, a few years ago, we had to wait a few days to see how things developed, and often it was then too late to save the patient.

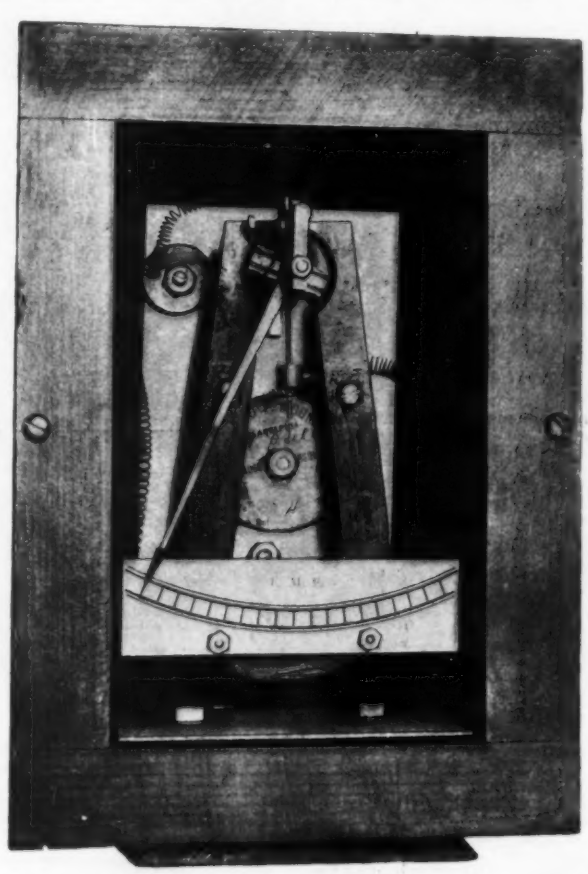
As far as we know, the antitoxin produces transient immunity, lasting several weeks. Vaccine immunity lasts a long time. We are finding out in regard to vaccination that it is not surely protective for a lifetime in some cases only for eight or ten years. The wise man who is going to be subject to infection from smallpox will get vaccinated every time he is exposed to the disease. Every child ought to be vaccinated; and every young person ought to be revaccinated at the age of eighteen or twenty. We have so little smallpox in a city like Philadelphia (only one or two cases a year, or, sometimes, no cases in a year) that we are really running no very great danger if we are not vaccinated frequently after we are grown up, unless an epidemic occurs, when everybody should be revaccinated.

I trust that I have said enough in this talk this evening to make you all feel that little things are not to be despised and that we have possibly had too harsh an opinion of bacteria in the world at large. There is no doubt that we are just on the threshold of the science; and that, within a very short time, we shall have many discoveries which will heighten our appreciation of their uses and which will enable us to make our living more comfortable, more satisfactory, and more safe than it has been in the past.

THE CONSTRUCTION OF A VOLTMETER AND AMMETER SUITABLE FOR A SMALL SWITCHBOARD.

By NEVIL MONROE HOPKINS.

DYNAMO and motor tending, unaccompanied by suitable means for reading the voltage value, current strength, and power, whether for commercial or experimental purposes, places the electrician in charge of a machine in an inefficient capacity, when not in an altogether impossible rôle. As an accompanying equipment for the numerous small motors and generators, the working drawings and designs of which are to be found in the columns of the various technical periodicals, the little indicating instruments described for construction in the following pages are primarily intended. With a sensitive voltmeter placed across the feeders of one of these small machines, the speed of its armature can be "observed" and held constant, and with a delicate ammeter included in its circuit, the very pulse of the machine can be "felt" at any instant of its performance.



VOLTMETER.

It is with the wish of assisting those who have constructed electrical machinery on a small scale that the writer gives the following directions for making simple forms of indicating instruments, and gives instructions for their calibration and care. Instrument making requires considerable skill and nicety of workmanship, and the writer feels that he should impress upon those seeking sensitive and delicate action of their product to work with neatness and care, approaching the exactness of the watchmaker's art as far as possible, not only in turning and polishing the all-important pivots and their little conical seats, but in the entire assembling of all portions and their final adjustment. These instruments, carefully and accurately made, will fully repay one for the time and slight expense incurred. The voltmeter and ammeter are illustrated in Figs. 1 and 2 respectively, with plan and edge views which are the reproductions of working drawings.

The voltmeter, which we will first take up, embodies the well known principle of the old D'Arsonval galvanometer, which has won for itself such universal popularity in fine laboratory measurements. As will be seen,

the fields of this voltmeter are made from a pair of common horseshoe magnets, bolted together, and cored out on the lathe to receive the little moving coil of wire. The reading scales as given in the illustrations are of arbitrary character, and not the result of calibration, which will be discussed later. The most satisfactory way to commence the making of this instrument is the choosing and cutting out of the magnets. For the purpose we will require two 6-inch magnets, measuring from the tips of the poles to the outside curve at the top, chosen well mated, that is to say of the same shape as near as possible, in order that they will coincide at the poles when bolted together. Any slight overlapping, of course, is not serious, for the coring out on the lathe after the two magnets are firmly bolted together reduces all vital irregularity, cutting the cylindrical opening from the two thicknesses of steel absolutely true.

The magnets are now placed in a charcoal furnace one at a time, and are raised to a cherry red heat, and allowed to cool slowly in a less intense portion of the fire. This annealing is necessary in order to allow of the cutting out and drilling for the bolts and screws, as the magnets are made from excellent hard steel, and when tempered are worked with the greatest difficulty, if they can be worked at all. Having drawn the temper, and of course incidentally the magnetism, the coring and drilling of the steel is a very easy matter. It will be observed that the poles are separated by a very small gap, in some 6-inch magnets only about $\frac{1}{8}$ inch. In order to make a sufficiently large lathe cutting for the movable coil of wire without boring away the best portion of the steel at the poles, they must be separated through a distance of at least $\frac{3}{4}$ inch. This reason will be made clear by a glance at the figures illustrative of the cored-out magnet. This separating is easily accomplished by placing the magnets in a vise in the manner indicated in Fig. 3.

The poles are placed directly against one jaw of the vise, and an iron rod is slipped in between them in such a way that it rests against the second jaw. By holding this rod firmly, and keeping it in a vertical position, when screwing up the vise, the pole pieces can be forced apart to almost any desired extent. Having spaced the poles just $\frac{3}{4}$ inch on each magnet, they are carefully placed together in a small hand vise, and firmly clamped for drilling. The position of the holes, which are just $\frac{5}{16}$ inch in diameter, with the exception of the two small ones, is shown in Fig. 4. The upper holes are just $1\frac{1}{4}$ inches from the pole tips, carefully measured, and the third hole is drilled through the center of the curving portion as shown. At an exact distance of $4\frac{5}{8}$ inches from the poles are drilled the two smaller holes which are to receive the screws of the scale plate.

Having completed this drilling, temporary iron bolts must be put in, and their nuts turned firmly on, holding the magnets securely together for the coring out on the lathe. This coring or circular opening must be, as indicated, just $1\frac{1}{4}$ inches in diameter, and is cut with a regular boring tool, with the work bolted on a lathe face plate. The magnets must be so placed on the face plate that the limit of the circular cutting just reaches the poles, leaving no mass of metal there for the lines of magnetic force to leak between. We can now remove the work from the lathe, but before taking the magnets apart, they must be marked with a file in order that they may be reassembled correctly after tempering and magnetizing. They are now placed separately in the fire for the second time, and raised in temperature to a full cherry-white color, and plunged immediately, poles downward, into a large pail of ice cold water. This most effectually replaces the temper, making the steel so hard that it is not possible to work it afterward, and it is for this reason that the holes for the bolts and scale screws must be very carefully and accurately located beforehand.

In order to replace the magnetism, it is only necessary to draw the magnets separately over the poles of a powerfully excited electromagnet. The horseshoe magnet is allowed to strike the poles of the electromagnet with some little force about midway up, when it is drawn backward and pulled away. This process is repeated about a dozen times with each magnet, and the two are finally laid together, with their like poles, of course, in contact. The electromagnet is best made for and operated with an electric lighting current, and will prove a most useful addition to any experimental shop. The iron cores of this magnet should be at least one inch in diameter, and be provided with bobbins or spools sufficiently large to hold the proper length of wire of the right resistance to be connected direct with the electric circuit. As the most simple application of Ohm's law in combination with the carrying capacity of a given wire and its resistance suffices for making electromagnets of all sizes, it is not deemed necessary to give the space here to detailed directions for different wires and lighting pressures, because of the undoubted ability of the reader to design and make just what he needs in this line himself.

Having the magnets drilled, cored, tempered, and magnetized to such an extent that they will lift two or three times their weight, which is readily accomplished if the electromagnet used was powerfully excited, we can lay them aside for the present, and take up the work, which requires the greatest care and attention.

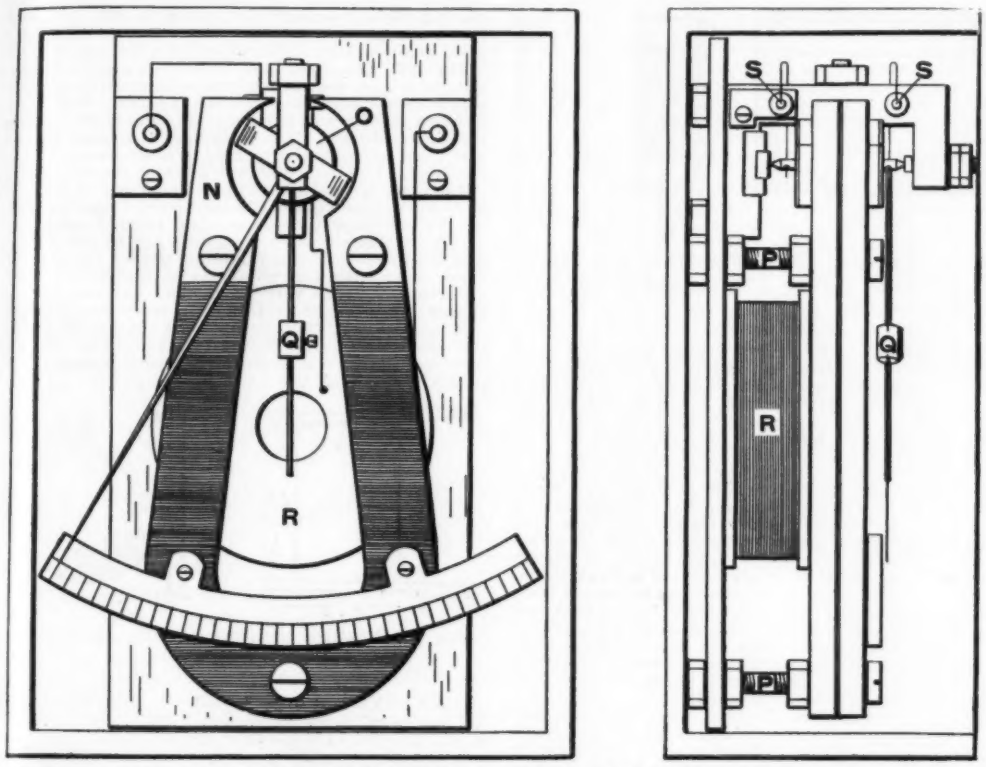


FIG. 1.—FRONT AND SIDE VIEW OF SMALL SWITCHBOARD VOLTMETER, MADE FROM HORSESHOE MAGNETS.

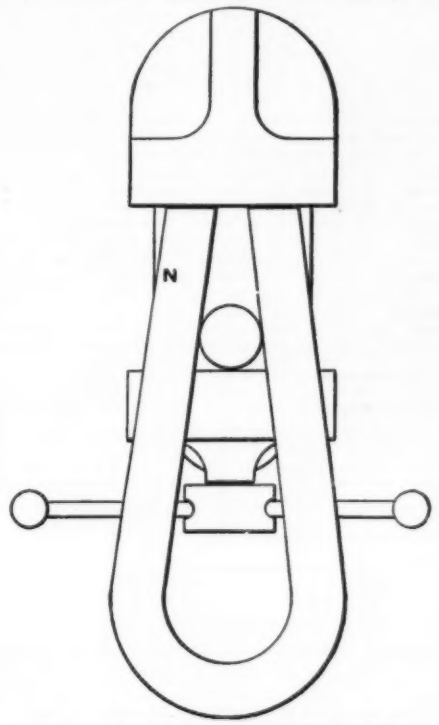


FIG. 3.—METHOD OF SEPARATING MAGNET POLES.

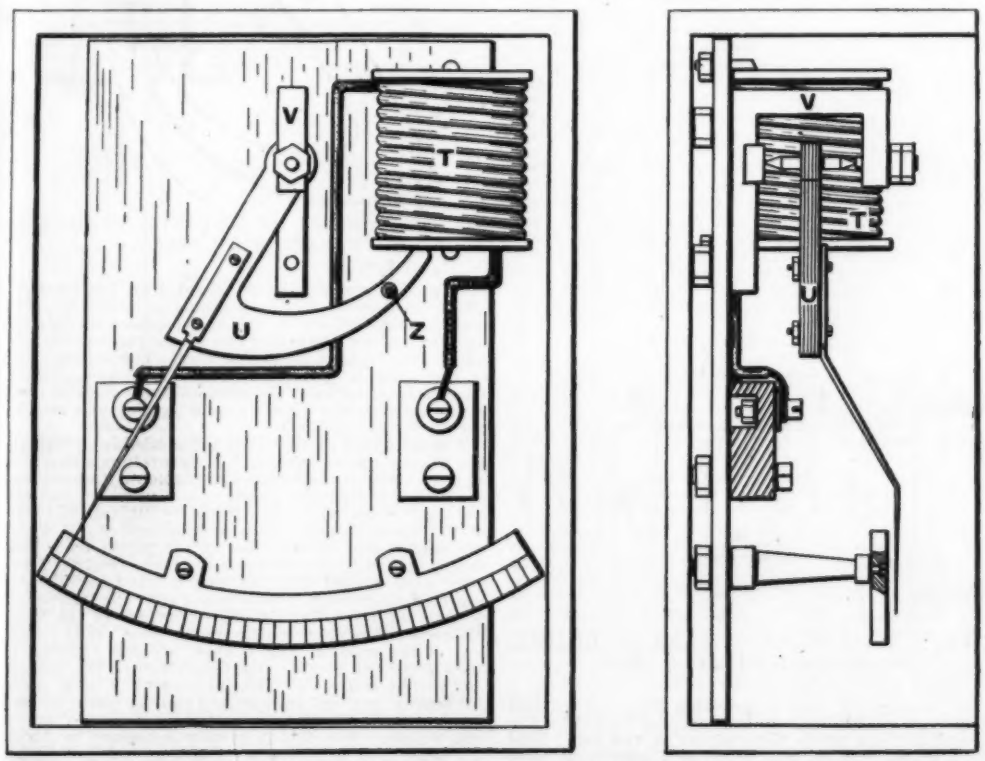


FIG. 2.—FRONT AND SIDE VIEW OF SMALL SWITCHBOARD AMMETER, SHOWING SIDE IN PARTIAL SECTION.

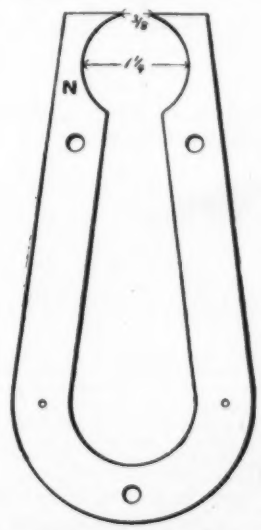


FIG. 4.—HORSESHOE MAGNET CORED OUT AND DRILLED.

This work consists in making and winding the little movable coil, and in providing it with its steel pivots. The frame of this coil must be light, and preferably of insulating material, in order to eliminate the danger of grounds and short circuits. The material chosen for

the purpose is cardboard, cut with a sharp knife in use with a steel straight edge, from a stiff visiting card. Fig. 5 illustrates the simplicity of making, the two little frames being cut out accurately to size, as shown at *A*, where the dimensions are marked on the diagram in fractions of inches. At *B* we have simply a little frame bent to shape, for gluing between the two cut-out frames, which give the whole stiffness and strength as soon as put in combination. At *C* we have the framing complete, looking at it from its upper edge. The gluing together must be very neatly done, and the work must be absolutely true when finished. Several coats of orange shellac must now be applied inside and out, and when hard, a tiny hole is drilled through the upper left hand corner as shown in the figure at *A*. The frame is now arranged for winding with its fine wire, which is conveniently mounted for revolving in the lathe as indicated in Fig. 6. Here we have an edge view of the little bobbin at *D*, mounted between the two nuts, *E E*, on the bolt, *F*, which is held in the chuck of the lathe.

We now come to the choice of wire and the winding, which must be governed by the voltage of the machine with which the voltmeter is to be associated. We have on this little frame a space available for wire, ¼ inch wide by a trifle less than ⅛ inch in height, we will say $\frac{3}{32}$ of an inch, $\frac{1}{32}$ of an inch being subtracted because of the thickness of the inner cardboard framing which is glued against the two outer pieces, and encroaching upon their width to this extent. The voltage most frequently met with is 110, with a maximum rise to about 125. Therefore, the instrument described is best wound to indicate between 0 volts and 125, including, in the opinion of the writer, nearly all the small machines described for construction, whether for power, lighting,

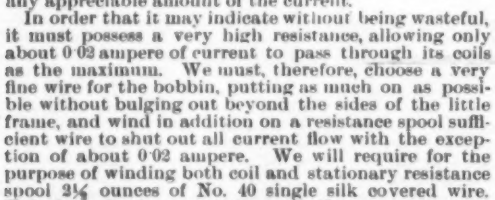


FIG. 5.—PORTIONS OF FRAME FOR MOVABLE COIL.

or experimental work. As this voltmeter is intended for switchboard work, it must be capable of remaining across the feeders of a current differing in potential by 110 volts, constantly without heating up or absorbing any appreciable amount of the current.

In order that it may indicate without being wasteful, it must possess a very high resistance, allowing only about 0·02 ampere of current to pass through its coils as the maximum. We must, therefore, choose a very fine wire for the bobbin, putting as much on as possible without bulging out beyond the sides of the little frame, and wind in addition on a resistance spool sufficient wire to shut out all current flow with the exception of about 0·02 ampere. We will require for the purpose of winding both coil and stationary resistance spool 2¼ ounces of No. 40 single silk covered wire. This fine wire is constantly weighed out on coarse or large scales, the weight, and consequently the resistance, of the wire being only approximate. In addition, the purity of copper in wire varies, and in some instances the gage, so it is wise to connect the wire across the feeders of a 110 volt circuit before removing

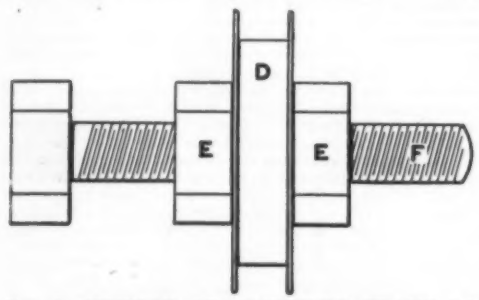


FIG. 6.—METHOD OF MOUNTING FRAME IN LATHE FOR WINDING.

from the spool upon which it was bought. The wire should warm up very little; in fact, to a scarcely noticeable degree, and when placed in circuit with a delicate ammeter should allow only 0·02 ampere of current to flow, of course, at the maximum pressure with which it is to be used. If the current absorbed by the spool is too great, more wire must be obtained and wound on; if the current taken falls short of 0·02 ampere, some of the wire must be removed. By making this test one cannot go astray.

The question is simply this: It requires at least this amount of wire to offer sufficient resistance to the high voltage current to shut out all but 0·03 ampere, which is the maximum carrying capacity of the wire itself. As much of this quantity as possible must be placed on the movable bobbin and the remainder must be wound on a spool and included in series. This wire is extremely fine and is to be handled with great care. In the first place do not, under any circumstances, allow the dealer to sell the wire wound on anything but a smooth wooden spool. Small wire is sometimes wound on a card or roll of paper for the purchaser, and should on no account be accepted in this condition. To attempt to handle wire of this size from anything but a spool will surely result in great delays, and the loss of the major portion of the material through kinking and tangling.

Having mounted the little framing on a bolt, as indicated, and placed the same in the lathe chuck, we are ready to fill it with the insulated wire. The reader must expect to exercise much patience here, and give a good deal of time and attention to the smooth laying on of the layers. The winding commences from the small hole in the cardboard frame, and the lathe is run away from the operator, or clockwise when facing the chuck. This wire is so fine that it should not be made to pass out of the little hole unprotected, as it is sure to break off and necessitate rewinding just as the coil is finished. In order to give it proper protection, its

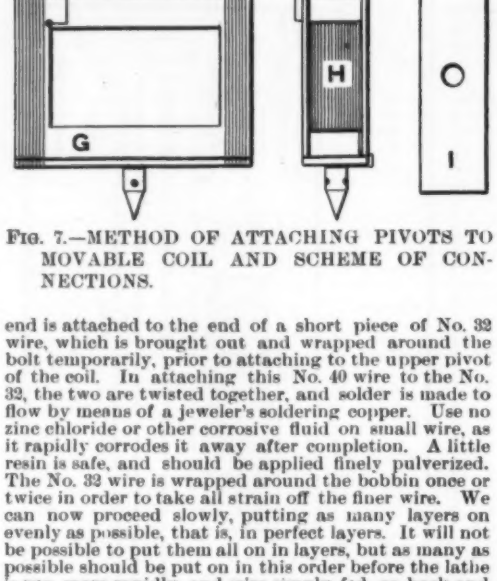


FIG. 7.—METHOD OF ATTACHING PIVOTS TO MOVABLE COIL AND SCHEME OF CONNECTIONS.

end is attached to the end of a short piece of No. 32 wire, which is brought out and wrapped around the bolt temporarily, prior to attaching to the upper pivot of the coil. In attaching this No. 40 wire to the No. 32, the two are twisted together, and solder is made to flow by means of a jeweler's soldering copper. Use no zinc chloride or other corrosive fluid on small wire, as it rapidly corrodes it away after completion. A little resin is safe, and should be applied finely pulverized. The No. 32 wire is wrapped around the bobbin once or twice in order to take all strain off the finer wire. We can now proceed slowly, putting as many layers on evenly as possible, that is, in perfect layers. It will not be possible to put them all on in layers, but as many as possible should be put on in this order before the lathe is run more rapidly, and wire simply fed on back and forth. A tiny hole should be made on the outer corner of the little frame when the coil is complete, and the wire drawn directly out. Should it break off here, it is not a serious matter, but should it break below, a repair is a very difficult thing to make.

We can now remove the work from the lathe, and provide the coil with little brass plates for the reception of the steel pivots. The scheme of attaching the pivots and their plates is illustrated in Fig. 7. The little coil is represented complete at *G*, with the top and bottom plates bound in place with silk thread. At *H* we have an end view with a single layer of wire wound on merely to show the connections, which are very simple, one end of the coil going to the upper plate, where it is soldered, and the other end going to the bottom, where it is attached in the same manner. At *I* we simply have the little plate drilled out to receive the pivot. The pivots are cut from steel rod ⅛ inch in diameter and $\frac{5}{8}$ inch in total height. The little brass plates into which the pivots are to be soldered are $\frac{1}{16}$ inch thick, leaving the point of the pivot $\frac{3}{16}$ inch above the surface of the plate.

These pivots are drilled through with small holes as indicated, and turned to fine cones in the lathe by means of a very sharp and fine tool. The work on these must be perfect, and if the first attempt does not bring true and smooth cones, a second set must be made. They are now held in the flame of a Bunsen burner, and heated to bright redness, and plunged into a vessel of mercury, which makes them extremely hard. Two little brass plates are now cut from brass 1-16 inch in thickness, and filed to just cover the upper and lower edges of the little frame respectively, by resting upon them. Holes are drilled through exactly in the centers with a ⅛ inch drill, and the little pivots pressed in. They must be absolutely in line before proceeding, which can only be expected as the result of accurate and skillful workmanship. Before soldering in position the little pivots should be polished by revolving in the lathe, and by applying the finest meal emery on cloth.

The little plates with their respective pivots are firmly bound on the framing with silk, as illustrated at *G*, the corners of the brass being filed smooth before winding on the silk to prevent its being cut. The ends of the coil are now securely soldered to the brass plates, and the whole given a good coat of orange shellac to keep out all moisture, which is liable to warp the coil in time, should this precaution be omitted. We are now ready for making the frame of brass which holds the little movable coil. This is cut out by means of a hack saw from a solid plate of brass ¼ inch thick, and has the dimensions and form as given in Fig. 8. This frame is neatly smoothed off with a fine flat file

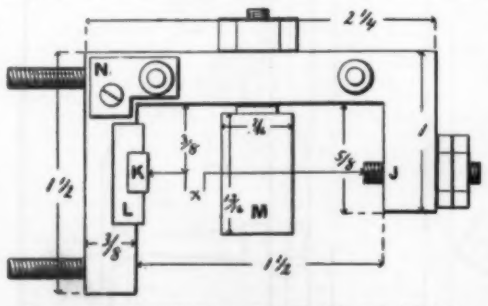


FIG. 8.—DIMENSIONS OF PLAN OF BRASS FRAME FOR MOVABLE COIL.

after sawing out, and is provided with a hardened steel screw possessing a conical cavity at its end for the reception of one of the little pivots of the coil. This screw passes through the frame at *J*, and is securely locked in position by a couple of nuts as shown.

The conical cavity in the end of this screw is conveniently made by drilling into the end with a small twist drill, before hardening in mercury as in the case of the conical pivots. The angle at the apex of the sunken cone, or conical cutting, should be a trifle larger than the angle at the apex of the cone on the pivot to prevent friction. In other words, the angle of the cutters on the drill must be more obtuse than the angle at the apex of the little pivot. In this manner we will have the movable coil supported simply by hardened points in tiny hardened seats. At the left of the frame, at *K*, we have a little hardened block of cast steel, also provided with a little conical cutting for the reception of the other pivot. This steel block is forced into a groove, cut in a piece of vulcanite, *L*, which in turn is forced into a cutting in the brass frame. A little shellac applied before forcing in place insures a permanent hold.

The exact size of the steel block and vulcanite insulation, of course, does not matter so long as the distance of the conical seat from the back is ⅜ inch. The space denoted by *N* is variable because of the screw, serving for the adjustment. The portion, *M*, is an edge view of a soft iron cylindrical core, held in place from a bolt at the back. The little hollow coil moves about this core without contact with it. This core is shown in position at *O* in the plan view of the completed voltmeter, Fig. 1. We must now provide a second piece of vulcanite, *N*, Fig. 8, which is screwed against the brass framing, and which carries a small binding screw. Small brass screw bolts with tiny nuts may be had which make these attachments very easy. The coil can now be placed in position in the frame, the screw being turned until a most gentle adjustment is established when the nuts are locked. Care should be taken, in locking the nuts, not to turn the screw further, thus damaging the points by undue strain.

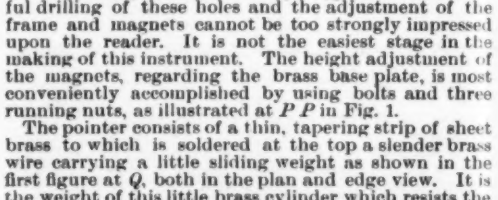


FIG. 9.—DESIGN OF SPOOL FOR AMMETER SOLENOID.

The frame is now to be bolted to a brass base plate, 3½ inches wide, 6¾ inches long, and ⅛ inch in thickness. The bolts are shown at the left in Fig. 8, the exact distance separating them being marked on the brass plate before drilling holes for them. The distance from the top of the brass plate to the top of the coil-supporting frame must be just ½ inch. The careful drilling of these holes and the adjustment of the frame and magnets cannot be too strongly impressed upon the reader. It is not the easiest stage in the making of this instrument. The height adjustment of the magnets, regarding the brass base plate, is most conveniently accomplished by using bolts and three running nuts, as illustrated at *P P* in Fig. 1.

The pointer consists of a thin, tapering strip of sheet brass to which is soldered at the top a slender brass wire carrying a little sliding weight as shown in the first figure at *Q*, both in the plan and edge view. It is the weight of this little brass cylinder which resists the turning of the coil, and must be adjusted to each instrument by the maker, when calibrating. It must obviously be placed at such angle that the index will point at *O* when the weight is vertical. The scale is

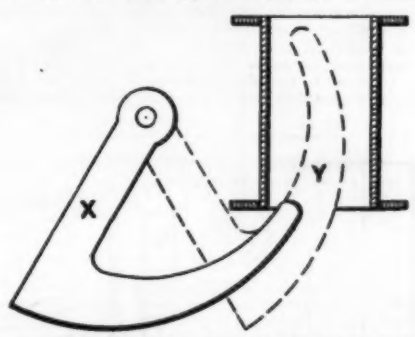


FIG. 10.—POSITION OF MOVABLE TONGUE IN RELATION TO SPOOL.

best made from cardboard glued to a brass pattern which is screwed to the magnets as indicated. The scale is struck off with a pair of compasses set for a 4½ inch radius for the center line of the reading portion, which is the length of the pointer. The actual width of the scale is ½ inch, and the maximum angular measurement between the position of the pointer when at the extreme right and left is 60°, giving us a reading arc 4¾ inches in length.

The resistance spool, which is included in series with the wire on the movable coil, is shown in position at *R* in both views of the finished instrument. Connections are made between the pivots of the movable coil and the binding screws on the frame by little spiral pieces of No. 40 bare copper wire, as indicated at *S S*, which are firmly held in the holes of the pivots by a little wedge and the end of the pointer respectively. These tiny wires should have an easy bend of considerable radius, and should not be touched after the instrument is once adjusted, for, although they are of the finest character, they exert a little spring force on the moving of the pointer, and if they are not touched or bent after the first setting, their effort on the moving coil will be constant. The instrument is now ready for testing and calibration, and can be made to read true volts direct or to indicate any arbitrary potential values. For this it is only necessary to divide the scale into equal parts. For true volts, however, it is necessary to compare the instrument with a standard voltmeter.

It is assumed that the reader wishes a complete instrument for direct volt values, and that he can have the use of a standard instrument for the purpose of comparing the readings. Both the standard and the instrument we are making are placed across the terminals of a dynamo and the machine started, its armature being driven until the observer knows that both voltmeters are properly connected and observes the indicators moving over their respective scales. The dynamo is now speeded up until the standard indicates 125 volts, when the little brass weight on our instrument is so adjusted that our instrument also indicates 125 volts. The weight of the little brass cylinder can here be determined by actual experiment in connection with its own individual instrument, which is far more accurate than written directions can be which are based upon another instrument.

The fields of the dynamo are now gradually weakened by turning the resistance of rheostats in, and the

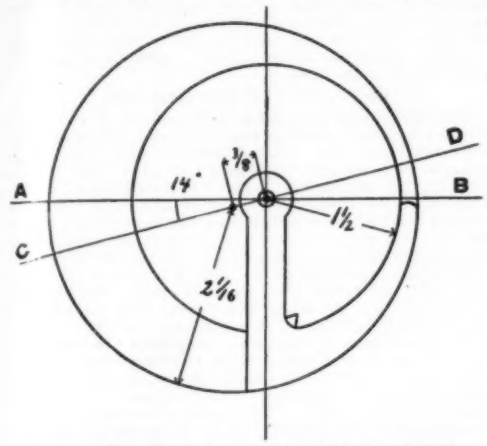


FIG. 11.—METHOD OF DRAWING PATTERN FOR MOVABLE TONGUE.

scale of the voltmeter is marked off to agree with the readings on the standard as the voltage gradually falls. The voltage will not fall to 0 with this method, of course, but will drop below the readings at which the instrument will prove most useful on the switchboard. To get the lower readings, the machine is started up, from a state of rest, with both voltmeters connected across its terminals and the rise in potential closely noted on the standard and marked on the scale of the instrument undergoing calibration. The processes should be repeated a number of times, going backward and forward, upward and downward on the scale until the values are fixed beyond doubt and the readings of our instrument agree with the readings of the standard at every point. A carefully and skillfully constructed instrument as described, when adjusted and calibrated in this manner, will indicate very slight differences in potential from 0 to 125 volts.

It now remains to case the instrument to keep out dust and dirt, and to screw it to a heavy, firm back board, together with the necessary switches, lamps and cut-outs, leaving room to the right for its sister indicator, the ammeter, which we will now take up for construction. The ammeter, which is illustrated in its completed state in Fig. 2, is much simpler in construction and operation than the voltmeter, and with the first instrument complete, the work on the ammeter can be carried on with comparative ease. The foundation of the ammeter consists of a brass plate ¼ inch thick by 4½ inches in width and 6¾ inches in height. To this firm bed-plate is attached the solenoid, *T*, and the movable iron tongue, *U*, supported by pivots in the

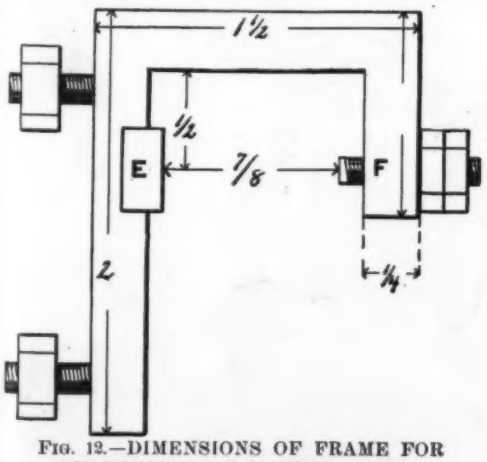


FIG. 12.—DIMENSIONS OF FRAME FOR SUSPENSION OF MOVING PARTS.

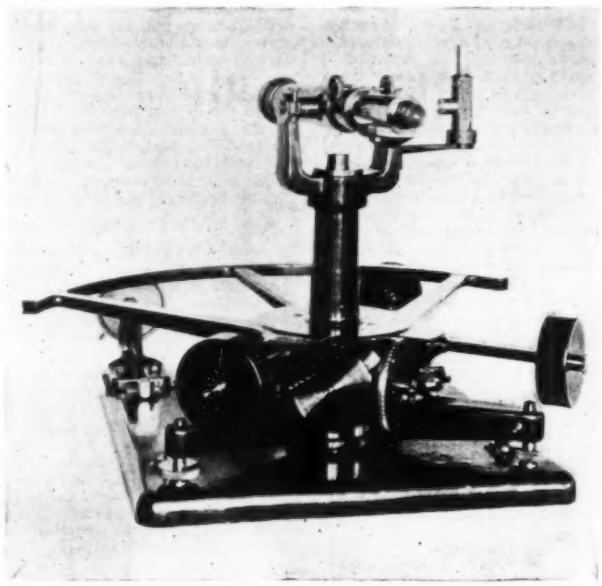
brass frame, *V*. The solenoid is made by winding insulated wire of large gage on a brass spool, which is attached to the back plate by means of bolts soldered to the top and bottom of the flanges. Fig. 9 will make the method of attaching clear, which gives also the dimensions of the spool. The center portion simply consists of a thin brass tube, upon which are soldered two turned rings of the same material, giving us a spool with ¼ inch flanges.

It is to these rings or flanges that the little bolts are soldered, furnishing a most convenient way of holding the spool rigidly against the back plate, indicated in dotted lines at W. The soft iron tongue must now be made, which, with its pointer, constitutes the movable portion of the instrument. Fig. 10 illustrates the exact form of this tongue, and its relation to the inside of the spool, which is drawn in section, the two extreme positions of the tongue being shown at *X* and *Y* respectively. This tongue must be built up from several thicknesses of soft Russian iron, thoroughly annealed. Before describing the method of making, a few words regarding the exact pattern of the tongue are necessary. This tongue must enter the solenoid as illustrated in the figure, and occupy its center when at the extreme position as indicated in dotted lines at *Y*.

In order to get this movement without the tongue and spool coming in contact, the tongue must be of peculiar shape, and Fig. 11 has been prepared to enable the reader to exactly reproduce it. Here we have simply two centers, one on the horizontal line, *A B*, about which a circle is described with a 1⅛ inch radius, and one on the oblique line, *C D*, about which a second circle is described, but with a 2 1/16 inch radius. The angle formed at the intersection of the two lines is 14°, and the distance apart of the two centers on the oblique line is ⅜ of an inch. By following these measurements with care, one cannot go astray in cutting a pattern for the tongue. A sufficient number of thin iron sheets must be cut accurately to the pattern with shears, to make a tongue about ¼ inch thick when laid together.

The different thicknesses are held firmly packed by tiny bolts and nuts, as shown in the edge view in Fig. 2, and in the plan view, at *Z*, is to be seen a little bolt head answering the double purpose of clamping the ends together and of affording means for balancing the tongue and pointer. It will be readily seen that a small mass of lead can be attached here without making contact with the spool when the tongue is drawn into it. The little bolt must be of iron in this case, to replace the iron which has been removed from the tongue in drilling the hole, in order that the gradually increasing mass of the metal shall not be diminished slightly at this point. The head of the bolt must be thinned down with a file, and the screw end must be provided with a brass nut, in order not to increase the mass of iron at this point. In this way we have drilled out a portion of the tongue and replaced the iron very accurately, affording means for clamping under the nut little lead washers.

The pivots in the ammeter consist simply of a piece of the steel as used for the pivots of the voltmeter, cut to length and turned off with a little cone at each end.



DISTANT INSTRUMENT FOR FINDING POSITION AND RANGE.

The pivot shank is forced into a hole drilled for it in the tongue, and securely soldered in place, exercising the greatest care to get it in perpendicular to the plane of the surface of the tongue. This of course is greatly simplified if the hole in the tongue has been drilled in with the drill perpendicular to begin with. We can now devote our attention to the brass frame, which is illustrated in Fig. 12, together with the dimensions. This is sawn from plate brass similar to that used for the frame of the voltmeter, being simpler to make, as the hardened steel block, *E*, is soldered in a cutting in the brass of the frame direct, as there is no need of insulating the pivot in the present case. We have at the right a screw, *F*, locked in place by the same kind of nuts. All the precautions of turning the cones with a smaller angle at the apex than the angle formed at the apex of the sunken cone by the cutters of the twist drill, in cutting the seat in the little steel block, must be exercised here again, and equal attention must be given to the most careful adjustment.

Before winding the spool with its wire, we must put the instrument together, and provide it with its scale and pointer, and the insulating blocks of hard rubber for the binding screws as illustrated. The scale, which is exactly like that of the voltmeter, is mounted upon a couple of little brass columns 1⅜ inches in height, in order that the plane of the scale and pointer shall be the same in both instruments, which adapts them to similar cases with the same sized scale openings. The upper portion of the brass frame, *V*, in Fig. 2 must be placed ⅛ inch from the top of the brass back plate, as in the case of the voltmeter, and the pointer of the movable tongue must sweep with a 4½ inch radius, measuring of course from the points of the pivot. This measurement immediately regulates the scale adjustment, which will be found to match the scale of the voltmeter nicely when the instruments are placed in cases.

Having placed the brass frame carefully on the center line, and bolted it with its movable tongue securely to the brass back plate, the spool must be mounted accurately in the relative position to the tongue, as given in Fig. 10. This will put everything in working order, mechanically speaking, requiring now our attention to the electrical side of the question, which consists in choosing and winding on the spool the proper amount of wire. This is a very simple problem, and should be worked out experimentally after the wire is chosen. Let us take for example the case where the ammeter is wished to indicate between 0 and 15 amperes. We must consult a wire table, and learn the sized wire possessing this carrying capacity. No. 10 has a capacity of 16 amperes, and consequently is able to remain in circuit continuously with 15 amperes flowing. The brass spool is wound with an even layer of this wire, experimentally, and the ends brought out for connection with a standard ammeter, which of course is included directly in series. The free ends are now run to the current supply, and included in series with that too, but through rheostats or water boxes.

The instruments are mounted together, and the pointer on our ammeter is balanced to the 0 reading. The current is admitted slowly by immersing the plate into the salt water of the rheostat, until the standard indicates 15 amperes. Where will the pointer on our instrument be? If we happen to have too many turns of wire on the brass spool, the pointer will go off the scale; if we have not enough turns wound on, the pointer will not reach the end mark. It will now be readily seen that it remains to take wire off, or to put more on, according to the behavior of the pointer regarding the range of the scale with which it is intended to work. By a little experimentation, we can get just enough wire on the spool to hold the pointer at the scale limit, or 15 amperes, for which we are designing the instrument, when the standard, which is in direct series, and consequently receiving the same current flow, also indicates 15 amperes.

It will also be readily seen that the ammeter can be made to indicate higher values by simply winding the spool with heavier wire and running through the same experiment. Of course, if a water rheostat is not at hand, the two instruments can be simply included in series with a feeder supplying incandescent lamps, and the instruments "loaded with current" by turning on lamps until the standard indicates the maximum amperes for which we are adapting our ammeter. For the points intermediate on the scale it is a very simple matter to gradually cut out lamps and make readings on the scale under calibration, when the standard indicates even ampere values between the limits. The current should be increased and decreased a number of times and the pointers caused to travel back and forth over the scales as in the case of the voltmeter. Both ammeter and voltmeter should now be provided with little stops for the pointers to prevent them from getting off the scale when they are ready for casing. The cases, for appearances, should be exactly similar and be provided with little lock doors and glass over the scale openings. The bottom portion of the cases should mount additional pairs of binding posts, which are intended for connection with the switchboard, taking all strain from the little screws within the instrument. Both instruments will be found extremely useful for switchboard use, their delicacy, sensitiveness, and accuracy depending, of course, upon the skill of the maker.

A HORIZONTAL-BASE RANGE AND POSITION FINDER FOR COAST ARTILLERY.

By GEORGE O. SQUIER, Ph.D., Lieutenant-Colonel, Volunteer Signal Corps, U. S. A., and ALBERT C. CREHORE, Ph.D., Assistant Professor of Physics, Dartmouth College.

IN December, 1896, the Board of Ordnance and Fortification made an allotment for the development of a horizontal-base range and position finder for coast artillery. This instrument was completed and installed at Fort Monroe, Virginia, in May, 1896, and has been in use by the artillery troops since that time. The description which follows is a brief account of the development of this instrument.

The desirable and essential features of a good range and position finder might be stated generally as follows: It should be simple, accurate, and reliable, and, as will be pointed out later, should be capable of receiving protection against the fire of the enemy.

The instrument now referred to possesses the following features:

a. No electrical parts except a single protected telephone line between the base ends.

b. No adjustments for variation in the tide, for curvature of the earth, for refraction, or temperature.
c. No daily adjustments of any kind required.
d. A base line more than a mile and a half in length.
e. The principal base-end instrument is an emergency depression range finder, to be used in case of need.
f. Can obtain the range of an object easily to within twenty yards in 10,000, or one-fifth of one per cent.
g. Can obtain the range and azimuth directly from any gun selected, as well as from the base ends themselves.
h. The telescope cross hairs are illuminated, so that the instrument can be used for night practice as well as day.
i. The range and position finder consists in part of two accurate azimuth circles and two telescopes specially designed for the needs of coast artillery.
j. The plotting is automatically made by two massless shadow bands indicating sharply the position of the object at regular intervals.
k. The plotting board presents a full graphical view of the field of fire, showing channel, shore lines, location of mines, etc., in their relative positions, and enables the commander to predict the future position of any ship selected.
l. The observer at the distant station can be directed to any particular ship selected with sufficient accuracy to prevent delay in identifying the target.

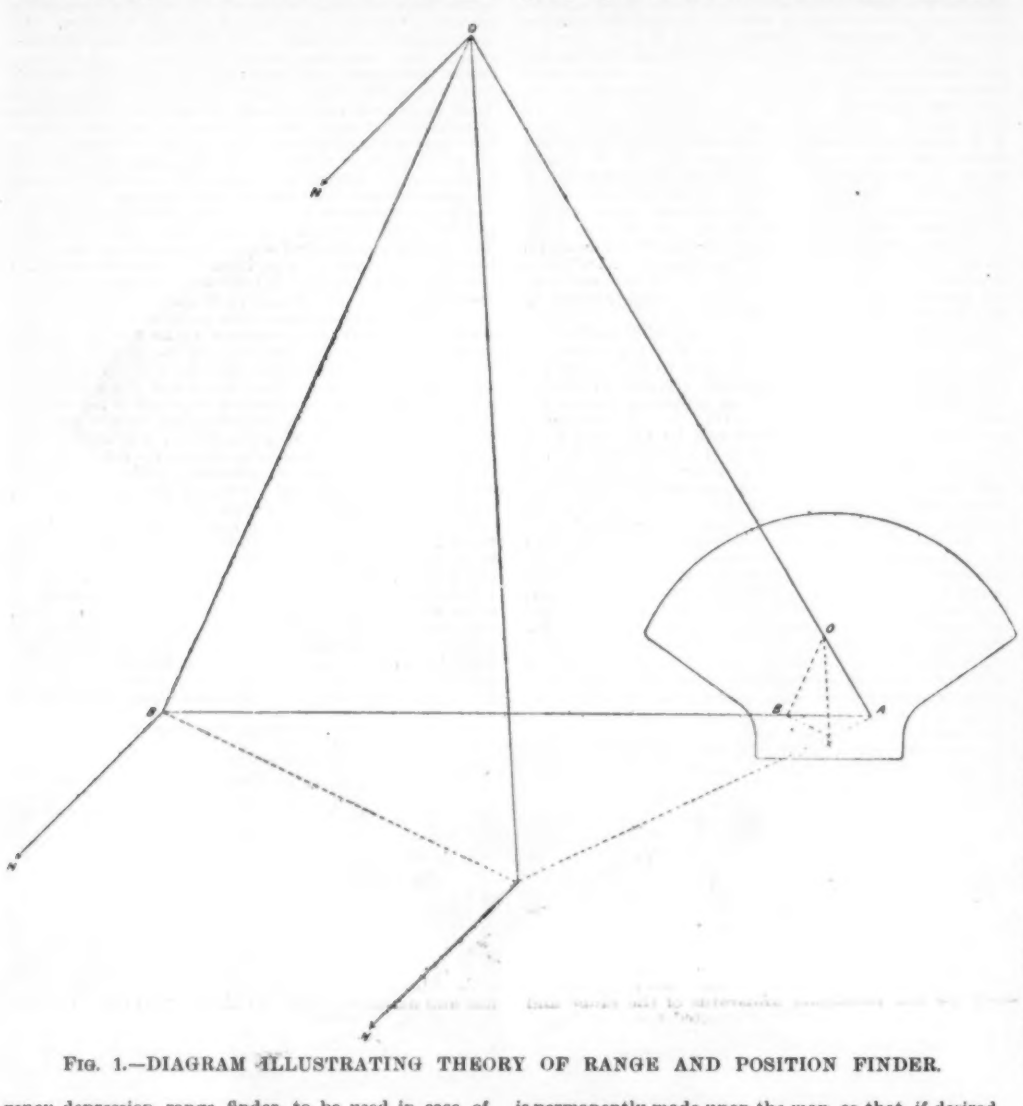


FIG. 1.—DIAGRAM ILLUSTRATING THEORY OF RANGE AND POSITION FINDER.

THEORY OF THE RANGE AND POSITION FINDER.

The range and position finder in principle presents an entirely graphical solution of the problem of locating an object. Let *A* and *B*, Fig. 1, be the home and distant stations at the extremities of a fixed horizontal base line, *AB*. Let *O* be an object which it is desired to locate. Let *X* represent the actual position of a group of guns which is to be furnished with the range and azimuth of the object, *O*. Let *XN* and *ON* be geographical meridians. Let *B'*, *O'*, and *X'* represent the corresponding positions on the map of the distant station, *B*, the object, *O*, and the guns, *X*, respectively. The polygon, *OBXA*, is, therefore, similar to the reduced polygon, *O'B'X'A*, on the map.

The operation is as follows: An observer at the telescope, *A*, keeps it continually pointed at the object, *O*, and by so doing causes a straight radial indicator upon the map to pass through the point, *O'*. An observer at the distant station, *B*, keeps his telescope pointed at the object, *O*, and at stated intervals of time previously agreed upon, as indicated upon a chronometer, the observer at *B* reads the azimuth angle, *NBO*, and telephones the same to a second operator at the home station. This operator, upon hearing the azimuth, sets his circle at *B*, which controls a second straight radial indicator, *B' O'*, upon the map, to read the same as that at *B*. This operation causes the indicator, *B' O'*, to be parallel with the line, *B O*, and, therefore, the intersection, *O'*, of the two radial indicators locates the position of the object, *O*, upon the map. A mark is made upon the plotting board for the point, *O'*, every quarter minute or half minute, as desired, which locates the object, *O*, as it moves, and gives an accurate trace of its course.

A range measuring arm and accompanying azimuth circle are then pivoted at a point on the map, such as *X'*, corresponding to the mean position of the group of guns, *X*, it is desired to serve. The range and azimuth are then read direct from the range arm and circle and then transmitted to the guns. The location of each group of guns and of the base end stations themselves is permanently made upon the map, so that, if desired, the range and azimuth may be furnished to all groups of guns from any desired point, to be relocated at the guns. It will be noticed that the observer at the telescope, *A*, never makes any readings, his duty being to keep the telescope upon the object, *O*, every quarter or half minute, and let the telescope remain in a fixed position after a setting is made until the recorder upon the board has marked the intersection, *O'*.

One of the special features in working out the practical details of the instruments is the rapidity with which a setting can be made by telephone and the object, *O*, accurately located. The angle is read at *B* on a large index wheel and telephoned to *B'* and a setting made which automatically locates the object in a very few seconds. It would take as long as this to make a setting by a galvanometer, and then, instead of being accurate to a minute of arc, the error of setting would be present.

Points are easily located on the vessel's course every fifteen seconds, though such short intervals are not required in practice. The plotting board easily enables the observer to predict where the object will be at definite stated times one or two minutes in advance of the observations. This rapid manipulation is not due to any special aptitude on the part of the observers, the men operating the instruments in everyday practice being non-commissioned officers in the regular service; but it is largely due to the automatic setting of the radial indicators, which locate the position of the object. These indicators have no mass, and merely consist of beams of light thrown from a projecting apparatus carried upon each axis above the plotting board. On this account it is not possible to introduce error by bending the arms, as frequently happens when mechanical ones are used.

DESCRIPTION OF INSTRUMENTS.

The range and position finder consists of two base-end instruments located one at either end of a fixed horizontal base line. One of the base-end instruments always has a plotting table as a part of it, and this station may be designated as the "home station" in distinction from the other, designated as the "distant station," which does not necessarily contain a plotting table. The working efficiency of the range finder, however, is increased by furnishing both stations with plotting board instruments, so that a separate group of guns can be served from each station. We will describe, however, the home instrument with the plotting board and the distant instrument without it.

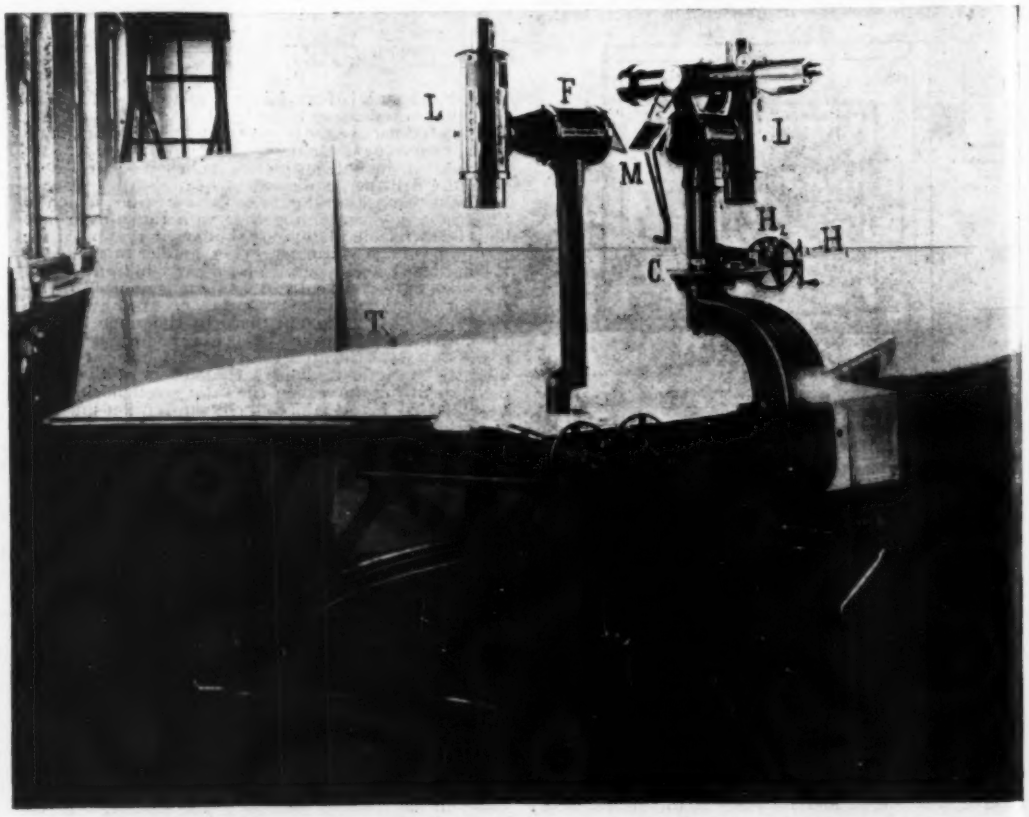
Mounted upon a substantial concrete pier, which is built to the level of the floor of the range finder house (see description later), stands the cast iron plotting table, *T* (see photographs), which is made at a convenient working height. This table has a large surface, which is machine planed over its entire extent, and has the shape suitable for a plotting board. Its narrowest dimension is about 6 feet and the longest 9 feet. A person can easily have access to any part of the board, and no injury can be done by sitting or leaning upon it. The table is finished with a special white enamel paint, which may easily be marked upon with a lead pencil, and the marks erased by an ordinary pencil eraser.

The whole instrument, with the exception of the brass work, is finished with olive green paint, and presents a neat appearance.

The scale of the map is 150 yards to the inch, and the table includes distances of 10,000 yards in its smallest dimension. $\frac{1}{3}$ of an inch represents 5 yards on the map, and the range-reading arm is graduated to thirtieths of an inch. Experience has fully justified the use of this scale intermediate between those of 100 and 200 yards to the inch respectively. To include a distance of 10,000 yards makes the table of prohibitive proportions with the 100 yard scale, while, with the 200 yard scale, it is not large enough to give the accuracy required.

The home and distant instruments are supplied with similar telescopes, specially constructed with reference to the range-finder problem. They have great light-gathering power, due to an aperture of 3 inches diameter, and while the magnifying power is as high as fifteen, the size of the field of view is comparatively large, giving two and one-half degrees by actual measurement. These telescopes are each fitted with means for illuminating the cross-hairs, so that the range-finder is ready for use at any time, night or day.

Each telescope is controlled by hand through the handles, H_1 or H_2, one for quick and the other for slow



GENERAL VIEW OF PLOTTING TABLE WITH BASE-END INSTRUMENTS.

motion, which turn the worm engaging the azimuth circle, *C*. One revolution of the handle, H_2, revolves the telescope through one degree. The index wheel, H_1, is divided into 60 parts, which, therefore, register minutes, one minute being a linear motion of nearly half an inch on the index wheel, H_1. The whole degrees are plainly marked, each having its own number stamped upon it, so that no possible error can arise from there being a choice of two readings.

The vertical axis upon which the home telescope is mounted intersects the plotting board at the point on the map where the home station is located.

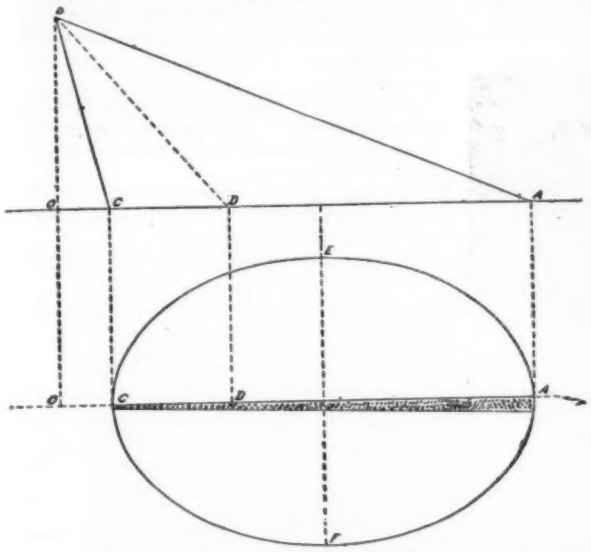


FIG. 2.—DIAGRAM ILLUSTRATING USE OF PLOTTING TABLE.

A second azimuth circle is provided at the plotting board to correspond with the distant circle, and this is operated through the handles, J_1 and J_2, one for quick and the other for slow motion, to enable the operator to make a setting by the index wheel, J_3, when the angle is received by telephone from the distant station.

THE SHADOW BAND INDICATORS.

The position of the object to be located upon the map is indicated by two massless radial indicators, which consist of beams of light and shadow. Carried upon each axis, corresponding to the home and distant stations respectively, is an apparatus for light projection, consisting of a lamp, *L*, condensing and focusing lenses which are inclosed in the brass case, *F*, and a mirror, *M*, for reflecting the beam from a horizontal to an inclined position. In front of each condensing lens is a narrow steel straight edge, about an eighth of an inch wide, which corresponds to the lantern slide in an ordinary projecting apparatus, and gives upon the screen—in this case upon the plotting table—a magnified image of the steel straight edge.

In Fig. 2 the line, *O A*, represents the top of the plotting table and *O B* is the vertical axis of the telescope. *B* represents the origin of a cone of rays, *C B A*, which falls upon the table in a slanting position, the axis of the cone being *B D*. The plan view of the table, with the ellipse, *C E A F*, of illumination, is shown in the lower part of Fig. 2, the same letters denoting the same points. The steel ribbon throws its dark image across the center of the ellipse, and is capable of adjustment, so that the line, *A C*, may be made to pass through *O*. The arrangement of lenses and steel strip is also such that the focus may be brought out sharply all along the line, *A C*, at the extreme limit of the board as well as in the nearest position.

To illustrate how well defined the edge of the shadow band is, it will suffice to say that a setting may be made by bringing the edge of the shadow band to a given pencil point upon the table, and a repetition of this operation does not show a variation of a single minute in the reading of the azimuth angle.

Fig. 3 shows a plan of the top of the table with the light from the two sources, forming two luminous intersecting ellipses. Where the ellipses overlap, the light has double intensity. The two shadow bands show distinctly across the entire board, the greater portion of each band receiving illumination from one lamp only, and so receiving less intense illumination than the neighboring region. Where the bands intersect a dark diamond-shaped lozenge is formed, which receives no illumination from either lamp. The contrast between this dark region and the adjacent doubly illuminated region is so great that the inner point of this lozenge makes a very accurate indicator.

THE SOURCE OF ILLUMINATION.

The problem of obtaining a satisfactory source of light for the projection apparatus of the range and position finder has been experimented upon, and good results, considering every phase of the question, are obtained by the use of an acetylene gas burner.

Oil lamps were tried, and they are furnished with the instrument, but do not give sufficient illumination for the best results. They would do well at night, however, when there is no diffused sunlight to reduce the effect of the artificial light.

Electric incandescent lamps are at present used, and give plenty of illumination and satisfactory results.

The installation in the range-finder house of an acetylene gas generator makes the lighting plant self-contained, and, with ordinary care, the light is always ready for use. A moderate supply of the calcium carbide lasts for months. The character of the acetylene light is also better than the other lights mentioned, as it is more white in quality.

ACCURACY.

While one of the essential requirements for a range and position finder for coast artillery is that the location of objects shall be made with dispatch, it should not give second importance to the accuracy of results obtained.

A range finder should be at least as accurate as the accuracy of the guns which it serves demands.

It is believed that this quality is possessed by the instruments now described as used in daily practice. The course of a vessel as plotted always gives such a smooth curve that the points all appear to the unassisted eye to lie upon it. One important quality in the instrument is the fact that it gives such great accuracy at distances of 10,000 yards. It is not an exaggeration to state that a vessel can be as easily located within 20 yards at 10,000 yards distance as it can be located with less accuracy than this.

Observations were taken upon the "Brooklyn," on the day when the "Flying Squadron" left Hampton Roads for Cuba, and her course was plotted with great accuracy to the limit of the plotting board, 10,000 yards. Long before the vessel had reached this distance the water line and hull had disappeared in the haze. Her flag and masts were the only objects that could be seen through the telescopes.

Since this range finder contains an accurate set of telescopes and azimuth instruments, they are available for the location, planting, and judgment-firing of mines, and for standardizing other instruments which are used.

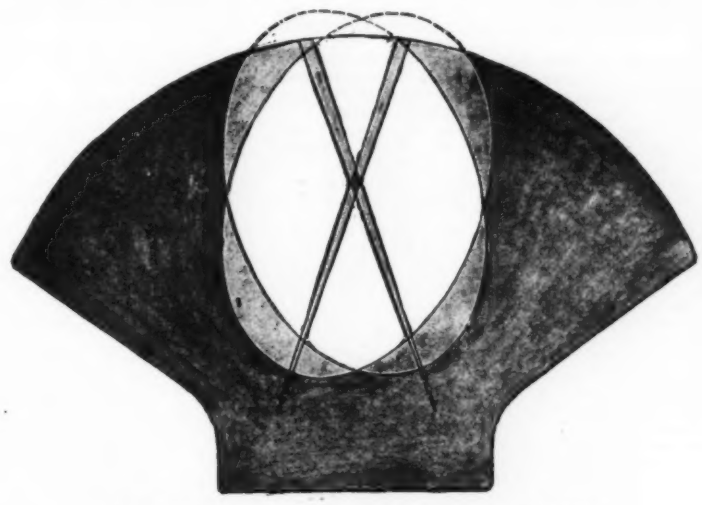
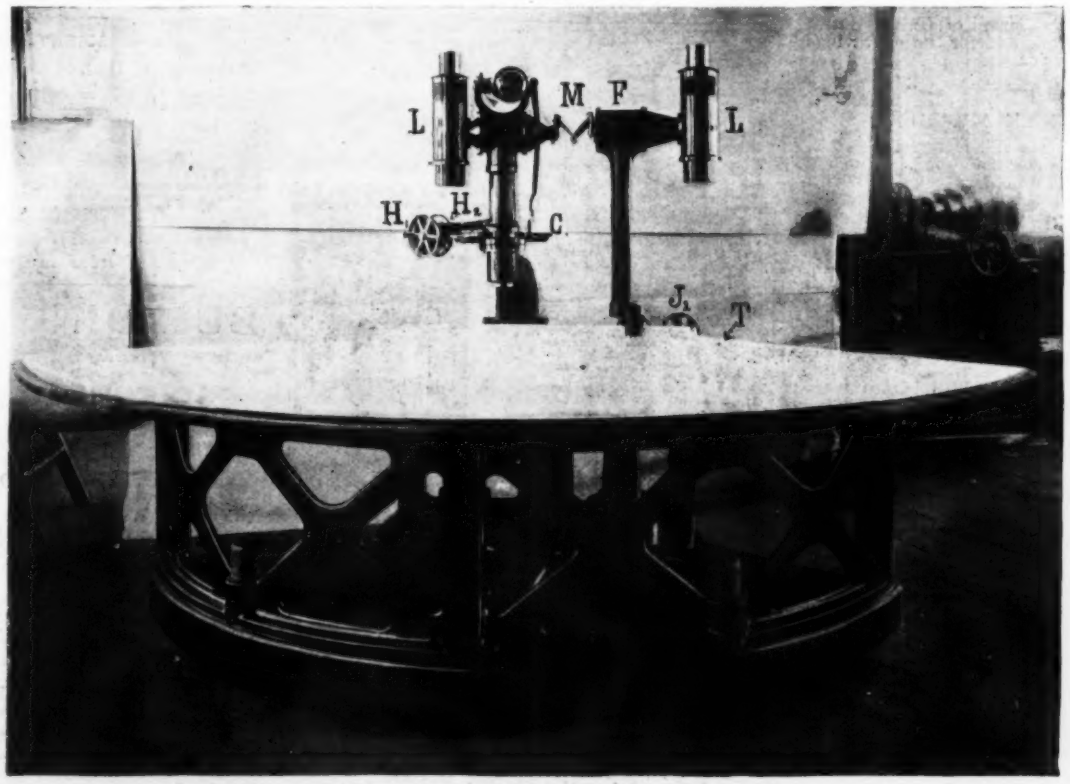


FIG. 3.—PLAN OF TOP OF PLOTTING TABLE.



PLOTTING TABLE SUPPORTING BASE-END INSTRUMENTS.

THE BASE-END HOUSES.

For the mounting of these instruments two protected houses were constructed of concrete, supported by sand in front and finally covered with earth and sod. These houses are each about 18 feet square inside, and have a semicircular front. Each has a water-tight cellar beneath the main room, for the location of the acetylene gas plant and for storage purposes. The walls of the

houses throughout, including the roof, are concrete, 2 feet thick, and the roof is supported by steel girders. A narrow observation slit, extending around the semicircular front, is supplied for the use of the telescope. The working room is normally sufficiently darkened to show distinctly the shadow bands used for plotting, but also light enough to see everything plainly in the room.

CONCLUSION.

The subject of a simple, accurate, and reliable range and position finder for, coast artillery is one of great importance. This problem is particularly important to the United States at this time, when a policy of building defenses for our coast cities is being carried forward. No pains should be spared to develop the most efficient of these instruments for installation at the new fortifications.

The experience gained during the past few months should prove of great value to the coast artillery, and do much to present the problems in their true aspect, although not a single shot was fired at our coast.

The fact that a Spanish fleet was expected at any time during the earlier period of the war with Spain put a life into the coast artillery which is impossible in time of peace. It was this experience which presented the range and position finder problem in a clearer light.

To take the single case of the new mortar batteries now at several points along the coast, they are practically useless without a range and position finder to furnish the location of the target. Sunken behind immense parapets of sand and concrete, the battery commander can do nothing until furnished the desired information. Furthermore, he can do service only so long during an action as his range and position finder is intact. The moment the latter is disabled or destroyed, that moment his sixteen mortars are out of the fight, and all is confusion. The range and position finding system for such a battery is then more important than any one of the mortars, for the commander loses the use of the whole sixteen the moment it is gone.

From this it logically follows that the range and position finder for such a battery should be protected from the enemy's fire, and since upon it depends the use of the entire battery, it should have at least as much protection as the mortars themselves.

This condition of protection for the range and position finder immediately rises to the importance of alone deciding against any instrument for such batteries which cannot receive it.

Again, from the economical standpoint of investing a certain amount of money to insure certain results, it is economy to invest, if necessary, an amount of money equal to the cost of a mortar in the range finder, if thereby any efficiency or reliability is gained for the working of the whole battery. Any commander would rather have fifteen mortars, which he is reasonably certain of, throughout an engagement, than sixteen, all of which may be put out of action at any time by a single shot destroying the range finder. It appears then from a business standpoint alone, that as long as a mortar battery and its armament and ammunition costs what it now does, it is unwise to permit any consideration of cost to stand in the way of the best range and position finder for the purpose, since the most elaborate instrument could not approach the cost of a single mortar, nor indeed the cost of a few rounds of ammunition for the battery.

We are indebted to The Journal of United States Artillery for the above article and for the engravings which they have kindly lent us.

THE FRENCH SILK INDUSTRY.

THE production of the Lyons silk factories in 1897 is, according to the commercial attaché to H. M. Embassy in Paris, estimated at £16,300,000, as compared with £16,000,000 in 1895. This is the largest figure that has ever been reached. The steam weaving mills were kept busy, especially during the last six months of the year, and the hand weaving machines were particularly brisk. On the other hand, the manufacturers of plain pure silks complained seriously of the dearth of orders. Black silk tissues were little in demand, having given place to the more modern colored silks. From 1896 to 1897 the production of plain pure silk tissues, not including silk handkerchiefs, fell from £5,200,000 to £4,440,000, while the production in 1896 had already fallen off by £600,000. With regard to the other manufacturing districts for pure and mixed silks, such as St. Etienne, Roubaix, Tourcoing, and in Picardy, and the various hosiery, trimming, and lace factories, their output is valued at £24,600,000. In 1897 the manufactories of St. Etienne turned out goods to the value of £3,500,000, as compared with £3,466,800 in 1896. The total production of the district is valued at £3,680,000. On account of the change in fashions, the manufacture of plain pure silk ribbons shows a decrease of £320,000, but about one-half of this loss is compensated for by the increased production of plain mixed ribbons. The manufacture, also, of finished ribbons and velvets continues to increase, and the French houses still hold the first rank, notwithstanding the keen competition of the Swiss and German manufacturers. The United States now manufacture more pure silk ribbons than the French, and the production in this country appears to increase. The importations of silk tissue into France in 1897 amounted to £2,080,000 against £2,012,000 in the preceding year, and the exportations to £10,836,000 as compared with £9,880,000 in 1896.

M. Douliot (Revue médicale; Gazette des hôpitaux; Revue internationale de rhinologie, otologie et laryngologie) reports the case of a man who, as was the case with several others reported in the sixteenth and seventeenth centuries, learned to see through his nasal cavities after the successive loss of both eyes. The right eye had been lost in childhood; the other eye, as well as the nose, had been lost in a fall upon a stake. A year later he perceived that he was able to distinguish through the nasal aperture the light of day, and also brilliant objects placed beneath it. It is considered probable that the retina had been spared, and that there remained an opening of communication between the nasal fossæ and the orbital cavity.

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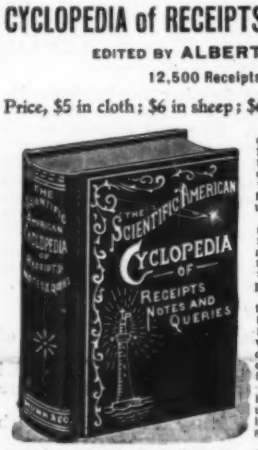

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